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WASSERHAUSHALT UND AUSTROCKNUNGSRESISTENZ VON SESELI LEUCOSPERMUM UND S. OSSEUM IM PLATTENSEE-OBERLAND

Von

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Wasserhaushaltsuntersuchungen wurden im Gelände mit Hilfe der Bestimmung des Wassersättigungsdefizits durchgeführt. Die untersuchten Arten leben auf oft austrocknenden Böden und sind daher in der Lage, die starke Belastung ihres Wasserhaushaltes in Trockenperioden zu ertragen.

Ziel der Untersuchungen war die Feststellung des subletalen Wasserdefizits beider Arten sowie der Gestaltung ihres Wasserhaushalts während der Vegetationsperiode. Neben dem Verlauf der aktuellen Sättigungsdefizite wurde auch die Transpiration gemessen.

Das subletale Wassersättigungsdefizit der endemischen Art *Seseli leucospermum* (*Apiaceae*) schwankte zwischen 60—68%. Der Verlauf der aktuellen WSD der Art zeigt, daß deren Werte im Falle ausreichender Wasserversorgung bei 3—12% bleiben. Bei Bodenaustrocknung konnten auch wesentlich höhere WSD gemessen werden.

Die Art transpiriert lebhaft. Bei guter Wasserversorgung kann ein zweigipfeliger Transpirations-Tagesgang festgestellt werden. Die Art ist in der Lage, ihre Transpiration in trockenen Perioden sehr stark einzuschränken (als Grenzwert wurden 4,4% gemessen).

Seseli osseum ist mit subletalen WSD von 72—77% eine sehr austrocknungsresistente Art. Die Jahres- und Tagesgänge der aktuellen Wasserdefizite der Art zeigen, daß diese zahlenmäßig stets die an ähnlichem Standort gemessenen Werte der obigen Art überschreiten. Die Werte schwankten zwischen 10 und 50%, wobei die obersten Werte durch die Wirkung der Trockenheit entstanden.

Die Art transpiriert lebhaft. Bei guter Wasserversorgung bleibt der Tagesgang der Transpiration mehr oder weniger im Verhältnis mit der Evaporation. Die Transpiration verflacht auf austrocknendem Boden und bei schlechter Wasserversorgung. Die Art ist zu einer wirksamen Transpirationseinschränkung fähig.

1. Einleitung

Seseli leucospermum W. et K. (*Apiaceae*) ist eine endemische Art der ungarischen Flora. Ihre Verbreitung beschränkt sich auf den westlichen Teil des Ungarischen Mittelgebirges. Die Art kommt von Keszthely bis zum Naszály-Berg auf meist flachgründigem Boden, überwiegend in den Pflanzengesellschaften von auf Dolomit entstandenen Rendzina-Standorten vor.

Es handelt sich um eine für Dolomit-Trockenrasen typische Art. Ihre Blütezeit liegt im Juli, die Reifezeit dagegen im Herbst, und deshalb ist sie in den trockenen Sommerperioden regelmäßig den schädlichen Wirkungen der Trockenheit ausgesetzt.

Der Verbreitungsschwerpunkt von *S. osseum* Cr. beschränkt sich ebenfalls im wesentlichen auf Ungarn, obwohl diese Art auch an mehreren Stellen

in benachbarten Ländern und Florenbezirken auftritt. Die Art zieht sich von den Dolomit-Trockenrasen bis in trockene Eichenwälder und oft sogar bis an den Rand von Kastanienwäldern und auf sandige Rasen. Ihre Früchte reifen eher als die der oben beschriebenen Art, aber auch *S. osseum* erleidet deutlich eine bedeutende Inanspruchnahme durch die Trockenheit. Die Arten flachgründiger Dolomit-Trockenrasen haben unterschiedliche Fähigkeiten, die trockene Jahreszeit zu ertragen; einzelne weichen den Trockenheitswirkungen aus, andere — so auch die untersuchten Arten — sind in der Lage, die Folgen der Bodenaustrocknung zu ertragen (LARCHER 1973). In südmährischen Trockenrasengesellschaften stellte RYCHNOVSKÁ (1966, 1975) bei *Stipa*-Arten im Falle extremer Trockenheit eine wirksame Senkung der Transpiration und eine nur mäßige Erhöhung der Wassersättigungsdefizite (kurz: WSD) fest. Ähnliche Ergebnisse erzielte auch FLORINETH (1974) in Südtirol.

An diese Untersuchungen schließt sich vorliegende Arbeit über die beiden genannten, an trockenen Hängen des Ungarischen Mittelgebirges vorkommenden und die Trockenheit gut ertragenden Arten an.

Andererseits schließen sich die Untersuchungen an von STOCKER (1929, 1933) und MAGYAR (1930, 1936) begonnene Arbeiten an. STOCKER untersuchte die Pflanzen von Kurzrasengesellschaften auf Szikböden, MAGYAR (1936) dagegen Arten, die für die Sandgebiete der Großen Ungarischen Tiefebene charakteristisch sind. Ungarns trockenstes Gebiet befindet sich im Tiefland, doch sind auch die Rendzinaböden des Mittelgebirges besonders gut geeignete Gebiete zur Untersuchung der Wirkungen extremer Trockenheit.

Ein weiteres Ziel der Untersuchungen war die Bestimmung autökologischer Charakteristika des Wasserhaushalts beider Arten wie des subletalen Wassersättigungsdefizits, des Ganges des aktuellen WSD, der Transpirationsintensität und deren Abnahme unter Standortsbedingungen.

2. Material und Methoden

Die Untersuchungen wurden im Keszthelyer Gebirge, hauptsächlich am SW-Hang des Lóberges (191 m ü. d. M.) durchgeführt. Der SW-Hang des Lóberges liegt über der Ortschaft Gyenesdiás dem Plattensee direkt gegenüber, wobei sich der erwähnte Standort fast 90 m über dem Wasserspiegel des Plattensees befindet.

Auf dem Kamm des Hügelzuges kommt *Seseli leucospermum* in offenen Stellen von Festuca-Rasen vor, während *S. osseum* die Standorte in unmittelbarer Nähe von *Quercus pubescens-Fraxinus ornus*-Buschwäldern vorzieht.

Die Untersuchungen wurden im Jahre 1975 in erster Linie mit *S. leucospermum*, 1976 dagegen parallel mit beiden Arten durchgeführt. Der Sommer des Jahres 1975 war aufgrund der Angaben der Meteorologischen Station Keszthely im wesentlichen gleichmäßig niederschlagsreich und mäßig warm. Die Monate Juni und Juli des Jahres 1976 waren hingegen sehr trocken und warm.

Zur Messung des Wassersättigungsdefizits wurde eine transportable Torsionswaage mit einer Genauigkeit von 0,1 mg benutzt. Im Laufe der Arbeit stellte die Wägung der aus fadenförmigen Zipfeln bestehenden Fiederblätter wegen ihrer gespreizten Stellung eine Schwierigkeit dar. Aus diesem Grunde wurde im allgemeinen mit einem Blattdrittel gearbeitet,

dessen rasche Wägung möglich war. Dessen Gewicht lag zwischen 50 und 150 mg. Bei *Seseli osseum* wurden etwas größere Blattstückchen mit einem Gewicht von 100—300 mg verwendet. Die Messungen wurden im wesentlichen nach STOCKER (1929) und BARRS (1968) durchgeführt. Die so vorbereiteten Blattdrittel wurden durch die Blattstiele mit Wasser aufgesättigt, deshalb steht dieses Verfahren der »Ganzblattmethode« näher als der in der neueren Literatur oft angewandten »Blattscheibenmethode«. Als Feuchtekammer wurden 130 mm lange biologische Reagensgläser mit einer etwa 1 cm hohen Wasserschicht verwendet. In diesen Reagensgläsern befanden sich auch 1 cm breite Filterpapierstreifen, die die entsprechende Sättigung der Kammer sicherten. Nach Einführen der Blätter wurden die Reagensgläser fest verschlossen. Anhand der Voruntersuchungen zur Aufsättigungsdauer wurden die allgemein üblichen 24 Stunden auf 12 Stunden abgekürzt. Die Voruntersuchungen ergaben nämlich, daß bei den von uns untersuchten Blattstücken der meßbare rasche Aufsättigungsabschnitt innerhalb von 4 Stunden abgeschlossen ist. Zur Feststellung des Wassergehaltes wurden die Blattstücke bei 105 °C im Trockenschrank getrocknet.

Die Bestimmung des subletalen WSD wurde nach OPPENHEIMER (1963) vorgenommen, aber nach Voruntersuchungen waren auch hier 12stündige Auf- und Rücksättigung ausreichend. Die Austrocknung der Blätter geschah im Arbeitszimmer auf Filterpapier. Vor der Rücksättigung wurde der abgeschnittene Blattstiel zurückgewogen und bei den Berechnungen berücksichtigt.

Die bei der Darstellung der Jahresgänge des WSD benutzten meteorologischen Daten sind Messungen der Meteorologischen Station Keszthely. Zwischen Meßstelle und Meteorologischer Station liegt eine Entfernung von 5 km.

Bei der Transpirationsmessung wurde die Momentanmethode nach STOCKER (1956) verwendet. Die Expositionsdauer der Blätter in natürlicher Lage betrug 2 Minuten. Die in mg angegebenen Transpirationswerte beziehen sich auf 1000 mg Ausgangswassergehalt. Nach der Wägung wurden die Blättchen in ein Reagensglas eingeführt, und es wurde auch deren WSD zum Zeitpunkt des Abschneidens bestimmt.

Die Messung von Temperatur und relativer Luftfeuchtigkeit wurde einen halben Meter über dem Pflanzenbestand mit einem Assmann-Psychrometer durchgeführt. Die Evaporation wurde mit grünen Filterpapierscheiben von 3 cm Durchmesser gemessen, ebenfalls einen halben Meter über dem Bestand. Die Werte auf den Abbildungen wurden nach RYCHNOVSKÁ (1966) auf 1000 mg feuchtes Filterpapier bezogen.

3. Ergebnisse

3.1. Subletales Wassersättigungsdefizit

Seseli leucospermum

Die Untersuchungen der ersten Serie wurden zwischen dem 24. 4. und dem 16. 7. 1975 durchgefürt. Je Pflanze wurde ein Blatt abgeschnitten und die Untersuchung in Serien von je 10 vorgenommen. Die Ergebnisse sind aus Gründen einer kurzeren Behandlung nicht dargestellt, ihre Werte sind folgende: (58) 61 (64) % (n = 114). Eine neue Untersuchungsserie wurde im Herbst des gleichen Jahres zwischen dem 25. 9. und 3. 8. an weniger Pflanzen durchgeführt. Die Ergebnisse sind in Abbildung 1 dargestellt. Ab einem WSD von 60% sinken die Rücksättigungswerte; unter eine 90%ige Rücksättigung fallen diese aber erst nach einem 68%igen WSD, so ist das WSD (63) 68 (75) %.

Das Ergebnis der zu Sommeranfang 1976 zum dritten Mal wiederholten Untersuchung stimmt gut mit dem des vorhergehenden Jahres überein. Ergebnis der zwischen dem 30. 5. und 28. 6. untersuchten Serie: (58) 60 (66) % (Abbildung 2).

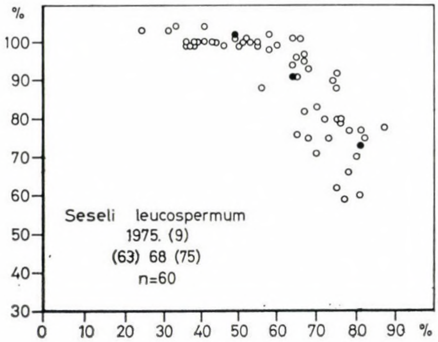

Abb. 1. Diagramm der Rücksättigungswerte. Abszisse: WSD. Ordinate: Rücksättigung

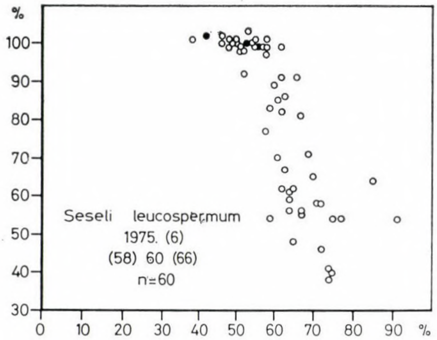

Abb. 2. Diagramm der Rücksättigungswerte. Abszisse: WSD. Ordinate: Rücksättigung

Den Ergebnissen aller drei Untersuchungen ist gemeinsam, daß die Rücksättigungswerte bis zum Erreichen des subletalen WSD wenig um die bei 101—102% verlaufende Rücksättigungsgerade streuen. Die sich daran anschließende, steil abfallende Gerade besteht dagegen nur aus stark streuenden Punkten. Diese Streuung, die auch besonders bei der ersten, nicht dargestellten Untersuchung auftrat, erlaubt die Schlußfolgerung, daß der Zusammenhang wahrscheinlich nicht linear ist. Diese Erscheinung wurde auch von OPPENHEIMER (1963) bei Blättern von *Phillyrea* beobachtet.

Seseli osseum

Die erste Untersuchung wurde am Sommerausgang und im Frühherbst 1975, vom 5. 8.—19. 9. durchgeführt (Abbildung 3). Als subletales WSD können (65) 72 (80) % angegeben werden. In einem Falle betrug die Rücksättigung nach einem 80%igen WSD sogar noch immer 93%! Die graphische Darstellung zeigt Ähnlichkeit mit der von *S. leucospermum*.

Die zweite Untersuchung wurde am Anfang des trocken beginnenden Sommers 1976 vorgenommen (Abbildung 4). Der graphischen Darstellung kann

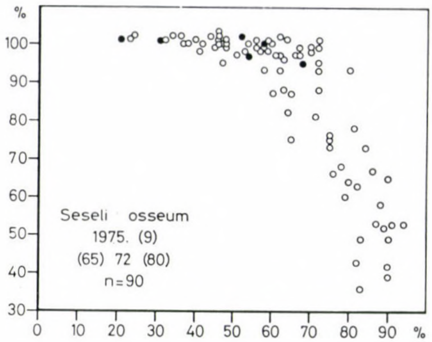

Abb. 3. Diagramm der Rücksättigungswerte. Abszisse: WSD. Ordinate: Rücksättigung

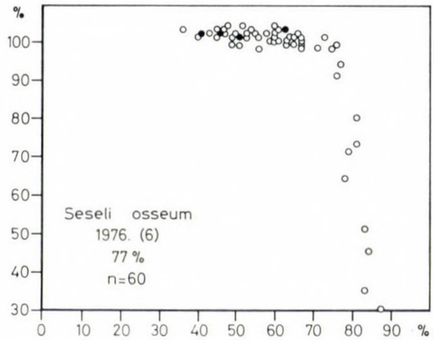

Abb. 4. Diagramm der Rücksättigungswerte. Abszisse: WSD. Ordinate: Rücksättigung

ein sehr hohes (77%) subletales WSD entnommen werden. Bei dieser Untersuchung wird der fallende Abschnitt nur von einer geringeren Pflanzenzahl gebildet, weil die Untersuchungen innerhalb eines kürzeren Zeitintervalls abgeschlossen werden sollten. Die subletalen WSD von *S. osseum* sind also eindeutig höher als die Werte von *S. leucospermum*, die zu einem ähnlichen Zeitpunkt gemessen wurden.

3.2. *Jahresgang des Wassersättigungsdefizits*

Untersuchungen des WSD bei *S. leucospermum* waren im Jahre 1975 nicht bekannt, so war es Hauptziel bei der Aufnahme des Jahresganges, die Extremwerte der jährlichen Schwankung festzustellen.

Auf Abbildung 5 sind mit einer durchgehenden Linie die 17 Nachmittagsmaxima verbunden, die täglich zwischen 13 und 14 Uhr gemessen wurden, wobei angenommen wurde, daß diese mehr oder weniger das Tagesmaximum darstellen. Die darunter verlaufende unterbrochene Linie verbindet die Werte von 5 Messungen, die morgens um 6 Uhr durchgeführt wurden. Im Laufe des

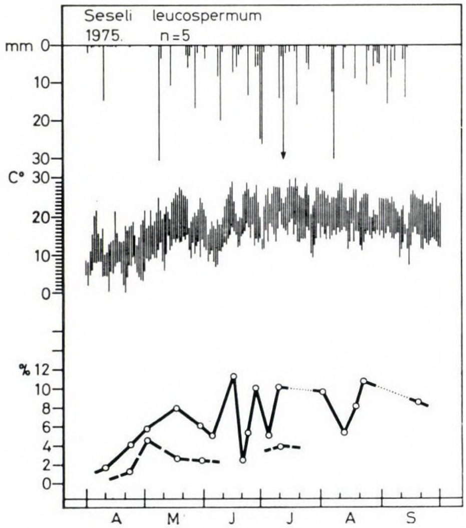

Abb. 5. Gang des WSD während der Vegetationsperiode. Ausgezogene Linie: Wert von 14 Uhr. Gestrichelte Linie: Wert von 6 Uhr

Sommers lagen diese Frühwerte mit Ausnahme des 1. Mai im allgemeinen um 2—3%. Das bestätigt, daß sich in der Nacht die Tages-Wassersättigungsdefizite von 8—12% ausgleichen. Der verhältnismäßig hohe Wert von 4,8% am frühen Morgen des 1. Mai kann durch einen sturmartigen Wind erklärt werden. Dieser Tag war einer der stürmischsten Tage des Jahres; die Windstärke betrug 10—21 m/sec.

Der Verlauf der Werte vom frühen Nachmittag folgte bei den ersten 12 Messungen dem Temperaturverlauf sehr gut. *Seseli leucospermum* litt auf dem flachgründigen Rendzinaboden sichtbar nicht an Wassermangel.

Die maximalen Werte des Jahresganges von 8—12% erlauben die Schlußfolgerung, daß *S. leucospermum* seinen Wasserhaushalt sehr gut reguliert.

Anhand des in der Vegetationsperiode gemessenen subletalen WSD (61%) entsprechen die Tages-WSD von 8—12% einer 13—20%igen Belastung des Wasserhaushaltes. Der höchste im Jahre 1975 gemessene Wert ist 18,8%, stellt auch nur eine 31% ige Belastung dar. Das ist wegen der das vieljährige Mittel überschreitenden Niederschlagssumme eine sehr mäßige Inanspruchnahme. Dazu kommt noch eine recht ausgeglichene Niederschlagsverteilung. In den Sommermonaten gab es lediglich 3—5 tägige regenlose Abschnitte, was eine sehr günstige Niederschlagsverteilung bedeutet.

1976 wurden neben *S. leucospermum* gewachsene Exemplare von *S. osseum* in die Untersuchungen einbezogen, da diese unter dem Wassermangel deutlich stärker litten. Die Angaben der Jahresmessungen 1976 (Abbildung 6) stammen teilweise aus Werten der Tagesgänge, von zwischen 13 und 14 Uhr durchge-

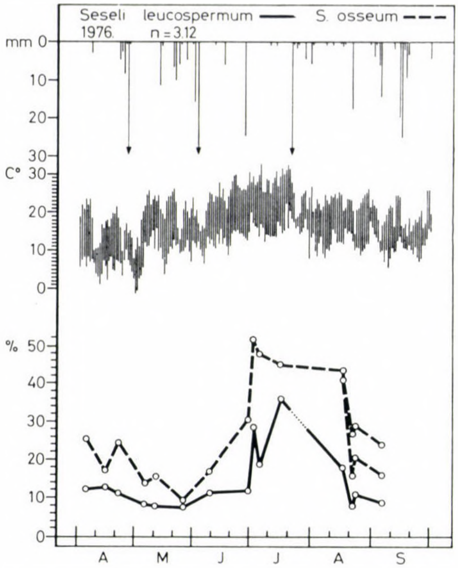

Abb. 6. Gang des WSD während der Vegetationsperiode (14 Uhr)

führten Messungen oder sind Mittelwerte besonderer Messungen. (Die Jahresgangmessungen bestanden in diesem Jahr aus 12 Parallelmessungen.) Dieses Jahr war wesentlich trockener als das vorherige und auch trockener als das mehrjährige Mittel.

Der Verlauf der Mittagsmaxima war schon Anfang April höher als im Jahr 1975 und zeigte im Mai dem gleichen Monat des Jahres 1975 entsprechende Werte. Von Mitte Juni ab und den ganzen Juli hindurch fiel verhältnismäßig geringer Niederschlag, und es war ziemlich warm. Infolge der Trockenheit litten die auf Rendzina gewachsenen Pflanzen immer stärker unter der Trockenheit. Die Messungen bestätigen den sehr sparsamen Wasserhaushalt von *S. leucospermum.* Am 2. Juli erreichte das WSD mit 49,7% seinen höchsten Wert, was eine 83%ige Inanspruchnahme darstellt. Am 16. Juli betrug das WSD 36,5%, was eine 61%ige Inanspruchnahme bedeutet. Zu diesem Zeitpunkt war die Trockenheit am größten, dieser Wert ist trotzdem etwas niedriger als der vorherige, weil er aus der Messung des Tagesganges vom 16. 7. stammt und so die gemessenen $n = 3$ wesentlich niedriger sind als die ansonsten gemessenen $n = 12$. Am 21. Juli fiel der erste Niederschlag, aber bereits nach dem 16. sanken auch die Mittagstemperaturen. Auch nach dem Regen mäßigsten sich nur vorübergehend die äußeren Zeichen der Trockenheit, die gemessenen WSD normalisierten sich erst gegen Ende August.

Die Kurve von *S. osseum* verläuft stets über der von *S. leucospermum.* Die Art erträgt auch äußerlich sichtbar größereWSD und sichert so ihre intensive Transpiration. Das Rekorddefizit betrug am 2. Juli 51,8%. Neben diesem

Mittelwert war der höchste Extremwert gleichzeitig 65,4%. Der Mittelwert entspricht einer 67%igen, der Extremwert dagegen einer 85%igen Inanspruchnahme bei einem auch sonst hohen subletalen WSD (77%) der Art! Bei den Blättern von *S. osseum* bildeten sich im Juli und August solche WSD heraus (51,8—43,7%), die die am Standort vorkommende obere Grenze der WSD von lebenden Blättern darstellen. Kurve b zeigt bei den Stengelblättern noch höhere Werte als bei den Grundblättern.

3.3. Tagesgänge des Wassersättigungsdefizits und der Transpiration

In der Vegetationsperiode 1976 wurden auch Transpirationsmessungen durchgeführt, mit denen im Zusammenhang in jedem Falle auch das WSD der Blätter festgestellt wurde. Von mehreren Messungstagen sollen hier die folgenden 5 vorgestellt werden: 11. 5., 9. 6., 29. 6., 5. 7. und 16. 7. Die Messungen vom 29. 6. und 5. 7. stellen nur einen kleinen Bruchteil des Tages dar, sollen hier aber trotzdem erwähnt werden, da sie in den sich immer stärker erhöhenden WSD die Wirkung der sich verstärkenden Trockenheit sehr gut veranschaulichen. Die Messung am 11. 5. erfolgte nach warmen und trockenen Frühlingstagen. Die täglichen Temperaturmaxima lagen bei 25 °C, und 13 Tage lang hatte es nicht geregnet. Der Verlauf der WSD ist mehr oder weniger flach. Die Pflanzen können ihren Wassermangel kontinuierlich kompensieren. Die Transpiration von *S. leucospermum* kann durch eine flache, zweigipfelige Kurve, die Transpiration von *S. osseum* dagegen durch eine einfach und über der ersten verlaufende Kurve beschrieben werden (Abbildung 7). Zur Vorgeschichte der Messung vom 9. 6. (Abbildung 8) muß bemerkt werden, daß am 2. 6. 31 mm Niederschlag fielen, worauf noch 3 Tage lang geringer Niederschlag fiel.

Die Temperaturen stiegen von 6 auf über 20 °C. So war noch am 7. Tag nach dem bedeutenden Niederschlag genügend Wasser im Boden. Der Verlauf der WSD verstärkt auch diese Annahme; die WSD steigen nicht wesentlich. Die WSD von *S. osseum* sind auch hier eindeutig höher als die von *S. leucospermum*.

Für die Transpiration von *S. leucospermum* ist eine eigentümlich zweigipfelige Kurve charakteristisch. Das Nachmittagsmaximum kann mit der Westhanglage erklärt werden. *S. osseum* zeigt eine schwach verflachte, einfache Kurve. Die Höhe der Werte weist darauf hin, daß beide in die Gruppe der sehr intensiv transpirierenden Arten gehören.

Nach dieser Messung wurde die Trockenheit immer stärker. Die folgenden unvollständigen Messungstage sollen lediglich das immer stärkere Ansteigen der WSD und die Abnahme der Transpiration veranschaulichen (Abbildung 9).

Am 16. 7. (Abbildung 10) war der Hang bereits hoffnungslos ausgetrocknet. Die Pflanzen waren stark gewelkt. Ziel der Messung war, diese die Trocken-

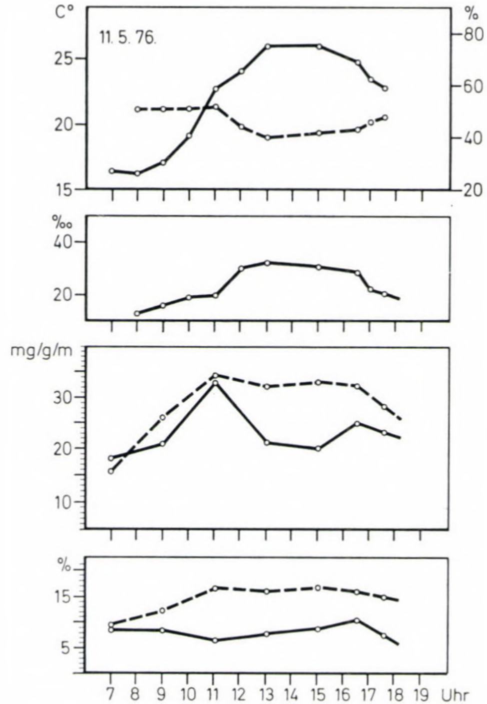

Abb. 7. Tagesgang (11. 5. 1976) der Transpiration und des WSD. a: Ausgezogene Linie: Temperatur; Gestrichelte Linie: Rel. Luftfeuchtigkeit; b: Ausgezogene Linie:Evaporation; c: Transpiration; Ausgezog. Linie: *Seseli leucospermum*; Gestrichelte Linie: *S. osseum;* d: WSD Ausgezogene Linie: *Seseli leucospermum;* Gestrichelte Linie: *Seseli osseum.*

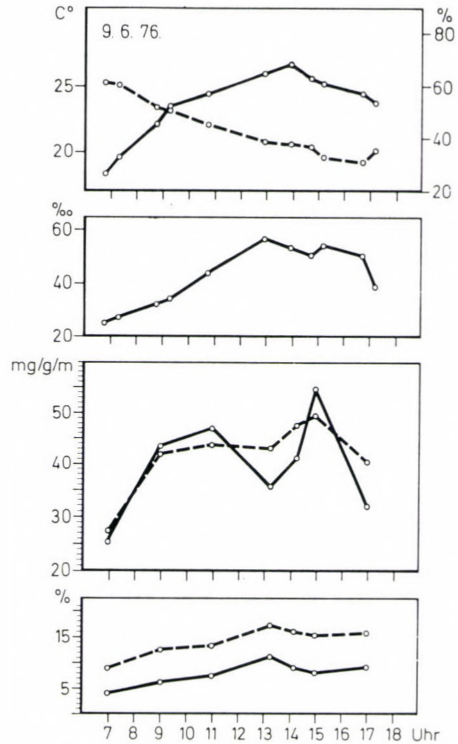

Abb. 8. Tagesgang (9. 6. 1976) der Transpiration und des WSD. Zeichenerklärung s. Abb. 7

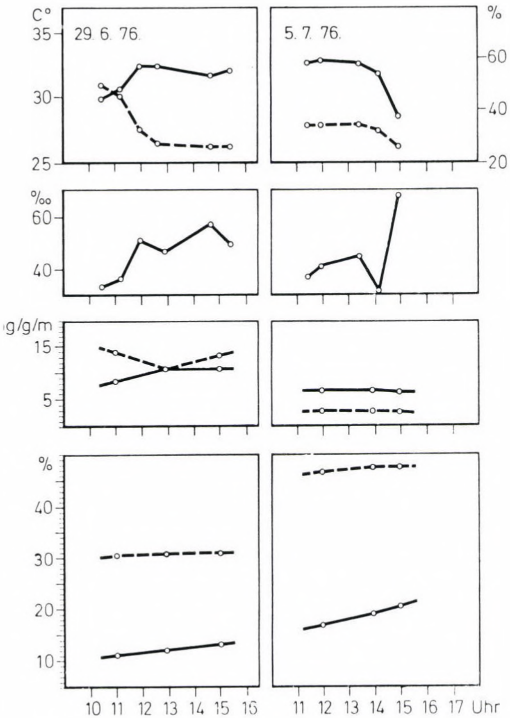

Abb. 9. Tagesgänge (29. 6. 1976 und 5. 7. 1976) der Transpiration und des WSD. Zeichenerklärung s. Abb. 7

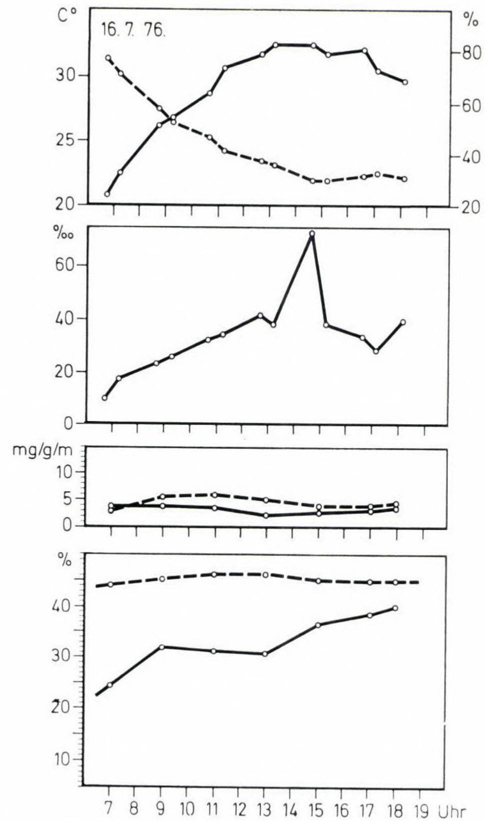

Abb. 10. Tagesgang (16. 7. 1976) der Transpiration und des WSD. Zeichenerklärung s. Abb. 7

periode charakterisierenden Meßwerte als Vergleichsgrundlage benutzen zu können. Die Trockenheit dauerte vom 27. 6.—21. 7. Eine Unterbrechuung stellten lediglich Niederschläge von ungefähr 1 mm dar, die infolge der hohen Temperaturen keinerlei Bedeutung hatten. So zeigen die am 19. Tag der Trockenperiode gemessenen Daten sehr gut die vernichtende Wirkung der Trockenheit bei zwei der trockenresistentesten Arten auf Rendzinaboden.

Die WSD verlaufen bei *S. osseum* am Tage fast horizontal und zeigen Werte um 45%. *S. leucospermum* zeigt dagegen noch immer einen schwachen Anstieg, was bedeutet, daß die Blätter dieser Art ihren Wasservorrat im Laufe der Nacht in geringem Maße verbessern. Die Transpirationswerte sind außerordentlich niedrig. Bei einem Vergleich mit den Maßdaten vom 9. 6. können die in der Tabelle angegebenen Aufmerksamkeit verdienenden Abfälle betrachtet werden.

Tabelle 1

Abnahme der Transpiration nach 19 tägiger Trockenheit (1976)

	S. leucospermum	*S. osseum*
Transp. vom 16. 7. in % der Transp. vom 9. 6.	8,4	11,0
Transp. vom 16. 7. in % des Maximums vom 9. 6.	6,1	9,3
Maximum vom 9. 6. und Minimum vom 16. 7.	4,4	5,7

4. Diskussion

Begriff und Bestimmungsmethode des subletalen Wassersättigungsdefizits wurden von Oppenheimer (1963) im Jahre 1932 vorgeschlagen. Höfler et al. (1941) führten den Begriff des kritischen Sättigungsdefizits sowie für die über diesem verlaufenden, aber noch reversiblen Rücksättigungswerte die Bezeichnung subletales Defizit ein. Es erscheint als selbstverständlich, daß die Rücksättigung der gewelkten Blätter bei den untersuchten Arten in einem einige Prozent breiten Bereich abreißt. Es ist deshalb schwierig, zu dessen Charakterisierung lediglich einen einzigen Prozentwert zu benutzen. Zur Kennzeichnung des Abrisses der annähernd horizontal verlaufenden reversiblen Rücksättigungswerte wurden aus diesem Grunde auch die Extremwerte in Klammern angegeben, z. B. (58) 60 (66) %. Zur Darstellung der Ergebnisse halten wir die Angabe der einzelnen Meßwerte für ausdrucksvoller als die Mittelwerte, wie das z. B. auch der Auffassung von Bornkamm (1958) entspricht.

Bei den untersuchten Arten konnte eine Veränderung der subletalen WSD im Laufe der Vegetationsperiode festgestellt werden. Diese Feststellung stimmt mit den Ergebnissen von ARVIDSSON (1951) und FLORINETH (1974) überein.

Die WSD-Gänge unterscheiden sich im niederschlagsreichen Vegetationsabschnitt 1975 und im trockenen Sommer 1976 vollständig voneinander. Die Frühdefizite von *S. leucospermum* sind im Falle guter Wasserversorgung relativ niedrig und liegen bei 2—4%. Diese zeigten während der trockenen Periode des Jahres 1976 (z. B. am 16. 7.) ein ganz anderes Bild; hier wurden auch am Morgen relativ hohe Werte gefunden. Gleichzeitig zeigt *S. osseum* als Zeichen noch schlechterer Wasserversorgung keinerlei Tagesschwankung.

Die Höhe der absoluten WSD verursachte allerdings eine gewisse Enttäuschung, da in der Literatur teilweise sehr hohe Belastungswerte zu finden sind (z. B. HÖFLER et al. 1941). In vorliegenden Untersuchungen wurden keine auffallend hohen Werte gefunden, obwohl die Pflanzen stark unter der Trockenheit litten. *S. osseum* erlitt deutlich sichtbar stärkere Schäden, was auch gut durch die höheren WSD angezeigt wird. Im Anschluß an die Trockenperiode war bei 14,0% der Pflanzen der Stengel vertrocknet, während das bei *S. leucospermum* nur bei 5,1% der Fall war. Bei einer derartig hohen Inanspruchnahme wurde angenommen, daß die WSD in einzelnen Blättern den Wert des subletalen WSD erreichen werden. Demgegenüber betrug bei *S. osseum* das Maximum neben hohen Mittelwerten 65,4%. Diese Erscheinung kann damit erklärt werden, daß die Blätter vor Erreichen des subletalen WSD absterben. (Vertrocknende Blätter wurden nicht in die Untersuchung einbezogen.)

Anhand der Transpirationswerte gehören beide Arten in die Gruppe der sehr intensiv transpirierenden Arten. Der auf 1000 mg Wassergehalt bezogene Transpirationswert wird benutzt, da dieser für Wasserhaushaltsuntersuchungen die anschaulichste Berechnungsweise ist (FLORINETH 1974, MAGYAR 1936, RYCHNOVSKÁ 1966, 1975). Die Ergebnisse der Transpirationsuntersuchungen erhöhten in unserem Falle die Brauchbarkeit der aus den Wasserdefizituntersuchungen zu ziehenden Schlußfolgerungen, wie das auch von BORNKAMM (1958) festgestellt wurde.

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XYLOTOMIC STUDY OF SOME WOODY PLANT SPECIES FROM CUBA, I

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This paper is a continuation of the dissertaion entitled "Xylotomic study of endemic species from Cuba" started in 1976. Now the authors present the most important anatomical features of the xylem, external morphology, occurrence and habitat of eight Cuban species, namely: *Garrya fadyenii* Hook. (*Cornaceae*), *Catalpa punctata* Griseb. ssp. *punctata* (*Bignoniaceae*), *Tabebuia lepidota* (H.B.K.) Britt. (*Bignoniaceae*), *Pera bumeliaefolia* Griseb. (*Euphorbiaceae*), *Trichilia hirta* L. (*Meliaceae*), *Guarea guidonia* (L.) Sleumer (*Meliaceae*), *Cupania glabra* Sw. (*Sapindaceae*), *Calophyllum antillanum* Britt. (*Clusiaceae*).

Materials and methods

The eight tested species form a part of a collection consisting of 23 samples which was brought to Budapest by M. VALES scientific research worker (Botanical Institute of the Academy of Sciences of Cuba). Blocks of the different woods were softened in an autoclave, then cross, tangential and radial sections were obtained. The sections were dyed in an aqueous solution of the microdyestuff of toluidin blue. The maceration of the xylem was performed by the SCHULZE's method (SÁRKÁNY—SZALAI 1964).

Length of the fibres and vessel elements, tangential and radial diameters of the vessels, width and height of the medullary rays, and other features were measured (BABOS and VALES 1977).

Minimum—maximum values for each anatomic feature of individual species were calculated from 50—100 measurements.

Suitably enlarged microphotographs were prepared of each section.

Exterior morphology and occurrence

Garrya fadyenii Hook.

Shrub or small tree up to 8—10 m height. Branches 4-gonous, pubescent; leaves opposite, oblong-elliptic to lanceolate, 3—7 cm long, obtuse or mucronulate at the apex, glabrous and shiny above, hairy beneath, when young. Inflorescence amentiform, densely tomentose, male one 2—3 cm long, ramificate, female one up to 5 cm long, bracts lanceolate. Male flowers: calyx 4-lobed, lobes linear, valvate, connate at the apex; petals 0, stamens 4, epipetalous, filaments free. Female flowers: calyx tube ovate with 2 short or inconspicuous opposite lobes; ovary unilocular, style 2; berry globose, black, shiny, glabrate, crowned

by the persistent style, 1—2-spermous, 5—7 mm in diameter. Seeds compressed, oblong.

This species is a very characteristic element of the montane regions of the Greater-Antilles, namely in Cuba, Jamaica and Hispaniola. In Cuba there it occurs in the Ranges of the Province Oriente and in the Sierra de Escambray (Prov. Las Villas), having a notable role in the second canopy and shrub layer of the montane rain forests, in the semidry serpentine rain forests, elfin forests, elfin woodlands and in the montane limestone thickets of the higher haystack mounts (Pico Potrerillo, Monte Libano-Monte Cristo; Borhidi 1973, 1974, 1976).

Catalpa punctata Griseb. ssp. *punctata*

Tree up to 20 m height. Branches glabrous; leaves opposite, 1-foliolate, cartaceous or coriaceous; petiole 7—25 mm long, plate elliptic or widely elliptic, 2.5—9 cm long, obtuse at both ends or sometimes emarginate at the apex, entire, glabrous or white-pubescent on both surfaces [ssp. *pubescens* (Griseb.) (Borhidi], shiny, reticulate-veined above, lepidote-punctate beneath. Inflorescence a few-flowered corymbiform panicle; calyx 4—7 mm long, corolla yellow with brownish-purple design on the lower lobes, 1.5—2 cm long; stamens 2, inserted, filaments filiform, anthers glabrous, staminodia 3. Capsule linear, very long, up to 70 cm or more, glabrous or puberulous 5—7 mm wide. Seeds linear-fusiform, 12—17 mm long, compressed, hairy.

This taxon is a subendemic one of Cuba, which occurs also in Isle of Pine and Andros. The vicariant subspecies [ssp. *domingensis* (Urb.) Borhidi] grows in Hispaniola (Borhidi and Muñiz 1971). It is a common tropical deciduous tree in the areas of seasonal dry climate, and can be found in all the coastal limestone forests, littoral woodlands, in the semideciduous and deciduous forests of the limestone dog-tooth areas and foot-hill forests of the haystack mountains. In the extreme dry region of the South-Coast of the Province Oriente, lives a dry-resistent ecotype of this species, *C. punctata* ssp. *pubescens* (Griseb.) Borhidi — with pubescent leaves and larger corolla.

Tabebuia lepidota (H.B.K.) Britt.

Shrubs or little trees up to 5—6 m height. Branches brown-lepidote, later glabrous. Leaves 1—5-foliolate, petiole 1—2.5 cm long or very short, leaflets oblanceolate to oblong-obovate up to 5 cm long, coriaceous, rotundate or retuse at the apex, sometimes cuspidate-acute, narrowed at the base, the leaflet terminal petiolulate, lateral ones sessile, all somewhat lepidote at least beneath. Flowers few, purple-violet or pink, 5—7 cm long, subsessile or with up to 1.5 cm long, ferrugineous lepidote pedicels; calyx asymmetric, brownish-lepidote, about 1 cm long; capsule 6—12 cm long, angled.

This species has a distribution pattern of Cuba—Bahamas (LÉON and ALAIN 1957). In Cuba, this shrub is very common in the dry serpentine scrubs and woodlands of West and Middle Cuba, extended from the Province of Pinar del Rio to Camagüey, which were named by the former Cuban authors as "serpentine savannas" or "cuabales". This plant never occurs on limestone areas in Cuba, and it is an excellent indicator plant of the seasonally dry serpentine areas characterized by a climate of 1000—1600 mm yearly amount of precipitation and a dry period 3—6 months long (BORHIDI 1973, 1974).

Pera bumeliaefolia Griseb.

Small tree up to 12—15 m height. Young branches covered by ferrugineous scales. Leaves elliptic-lanceolate, 7—9 cm long, obtusely acuminate at the apex, narrowed to the petiole at the base; lustrous above, squamate beneath. Peduncle 5 mm long, fructified pedicels 3 mm long; male calyx 4—5 dentate, stamens 4—5, capsule globose, 10—12 mm in diameter.

This species occurs in Cuba, Hispaniola and the Bahama Islands, having a Greater-Antilles—Bahamas distribution pattern. In Cuba it can be found in the second canopy and shrub layer of the lowland and submontane seasonal evergreen forests and semideciduous forests in all provinces of this country, except Havana.

Trichilia hirta L.

Tree up to 20—25 m height. Leaves imparipinnate, petioles and rhachis hirsute or glabrous; leaflets generally 9—21, more seldom 3—7, with a length of 3—13 cm, lanceolate, oblong-lanceolate, acute or acuminate at the apex, acute or rotundate and somewhat asymmetric at the base. Inflorescence: panicle; calyx cupular with 4—5 triangular-ovate lobes. Petals oblong to elliptic, 5—6 mm long. Stamens 8—10, staminal tube lobulate over the middle, lobes oblong, bidentate at the apex, villous on the inner surface. Ovary hirsute, sessile on the disc annular. Capsule globose, 1—1.3 cm in diameter, villous, with 2—3 cavities. Seeds 1—2 in each cavity, 6—8 mm in diameter.

This species has a neotropical distribution pattern occurring in all over Central and South America, in Mexico and Santa Cruz, but in the West Indies it can be found only in Cuba and Jamaica. In Cuba and Isle of Pines it is a very common, frequently predominant element of the first canopy in the semideciduous forests, littoral limestone forests and in the lowland and submontane deciduous forests of the limestone dog-tooth areas and at the foothills of the haystack mountains (BORHIDI 1973, 1974) in West and East Cuba (Sierra Maestra, Sierra de los Organos).

Guarea Guidonia (L.) Sleumer

High tree up to 30—35 m height. Leaves paripinnate, with 4—10 pairs of opposite, elliptic, lanceolate-elliptic or oblong-obovate, 8—25 cm long leaflets, obtuse or abruptly acuminate at the apex. Inflorescence racemous, axilar; flowers hermaphrodite; calyx cupular, short, entire or denticulate with 4—5 minute teeth, hispid. Petals 4—5, oblong, 5—7.5 mm long, free, greenish-white, densely pubescent on the dorsal surface. Staminal tube entire or shortly lobulate, anthers 8—12; disc emergent with a ring-shaped pubescence of rigid hairs. Ovary sessile on the disc, puberulous; capsule obovate, lignescent with 3—5 cavities, 1.5—1.9 cm in diameter, brownish; seeds 1—2 in each cavity, 9—13 mm in diameter.

This species is a neotropical floristic element occurring in the Greater Antilles (Cuba, Hispaniola and Porto Rico), Panama and tropical South America (León and Alain 1953; Alain 1969). It can be found in the humid and semihumid submontane and colline forest regions of all the Cuba and Isle of Pines, as an important evergreen forestal tree of the submontane rain forests of the Northeastern Mountains of the Province Oriente (Moa-Baracoa region), where it is a common tree in the second canopy layer, but some giant examples occur in the first one as well. This tree is rather frequent also in the first canopy of the submontane seasonal evergreen forests in the Sierra Maestra, Escambry, Rosario, and Organos Ranges, further in the riverside gallery forests of the West Cuban oak-and-pine belts, while it occurs somewhat rarely in the lowland seasonal evergreen and semideciduous forests, but is completely absent in the montane, high montane and in the dry lowland regions (Borhidi 1973, 1974, 1976).

Cupania glabra Sw.

Tree up to 30—35 m height. Bark smooth, gray; leaves large, mostly paripinnate, leaflets 7—14, predominantly alternate, oblong-obovate, rotundate to retuse at the apex, sometimes obtuse or acute, 6—20 cm long, margin dentate or subentire, glabrous or pubescent beneath. Inflorescence panicle axilar or terminal, puberulous, 11—20 cm long, ramificate. Flowers white, sepals pubescent, stamens 8, filaments short, anthers included, oblong. Capsule turbinate-globose, 1.5—2 cm in diameter, glabrous.

This species has a North Caribbean distribution pattern, occurring in Central America, Florida, Jamaica and Cuba. In Cuba it is a very common tree species, having an important phytocenological role in the second canopy of the submontane rain forests and in the first canopy layer of the lowland and submontane seasonal evergreen forests and, as an important evergreen element of the upper tree layer of the semideciduous forests (Borhidi 1973, 1976).

Calophyllum antillanum Britt.

Evergreen tree up to 30 m height with pyramidal canopy. Leaves coriaceous, lustrous, elliptic to oblong-obovate, 5—12 cm long, rotundate and emarginate at the apex, cuneate to obtuse at the base; lateral veins parallel, closely disposed, prominent on both sides. Inflorescence recemous, axilar or lateral, few-flowered shorter than the leaves; pedicels 4—10 mm long, flowers white, fragrant; sepals 4, orbicular, petals generally 4, stamens about 50, filaments free or connate at the very base; anthers oval, 2-locular; ovary unilocular, drupe about 2—2.5 cm in diameter.

This species is distributed all over the Antilles occurring in many variable, morphologically hardly discernible populations considered by the botanists as forms or higher infraspecific taxa. In the present paper we excluded from the *C. antillanum* Britt. the *C. utile* Bisse, the latter being a surely recognizable good endemic species of the serpentine mountains of the Sagua-Baracoa Massif in the Northern Oriente (Cuba) (Bisse 1974). The *C. antillanum* s. str. is a tree species of a considerable forestal importance; its timber is used for carpentry and joinery, the living tree is often planted in streets, parks and afforestations. In Cuba it occurs frequently in the submontane seasonal evergreen forests as emergent trees or members of the high canopy, and can be found in the lowland gallery forests and sometimes in the seasonally inundated swamp forests as well (Borhidi 1973, 1974, 1976). The predominant *Calophyllum* species of the submontane and montane serpentine rain forests in East-Cuba is the *C. utile* Bisse.

Wood anatomy

Garrya fadyenii Hook.

Wood porous diffuse; the ground mass of the wood is formed by polygonal-shaped fibres with thick wall and narrow lumen. Diffuse paratracheal longitudinal parenchyma. Medullary rays with one or more cells in width (Fig. 1). Tracheae are oval-shaped with small sizes. Number is 69 per 1 sq. millimeter. Tangential diameter 18.4—52.9 μ. Radial diameter 23.0—57.5 μ. Vessel members are 355.0—1065.0 μ long, rarely with bordered pits on the wall. Perforation plate is scalariform (parts indicated with → of Fig. 2). Heterogeneous medullary rays with 1—5 cells in width. Height 230.0—483.0 μ. Width 23.0—112.0 μ. Polygonal-shaped, small crystals in the cells of the medullary rays (Figs 2 and 3). Fibres are commonly ordered in radial lines. Diameter 16.1—25.3 μ. Thickness of wall 10.7—11.5 μ. Full length 781.0—1633.0. Tips of the fibres commonly ending in a peak, one side with saw-teeth, rarely forking.

Diameter of the longitudinal parenchyma cells 6.9—23.0 μ.

Height 51.1—265.0 μ. Cells contain mastic material.

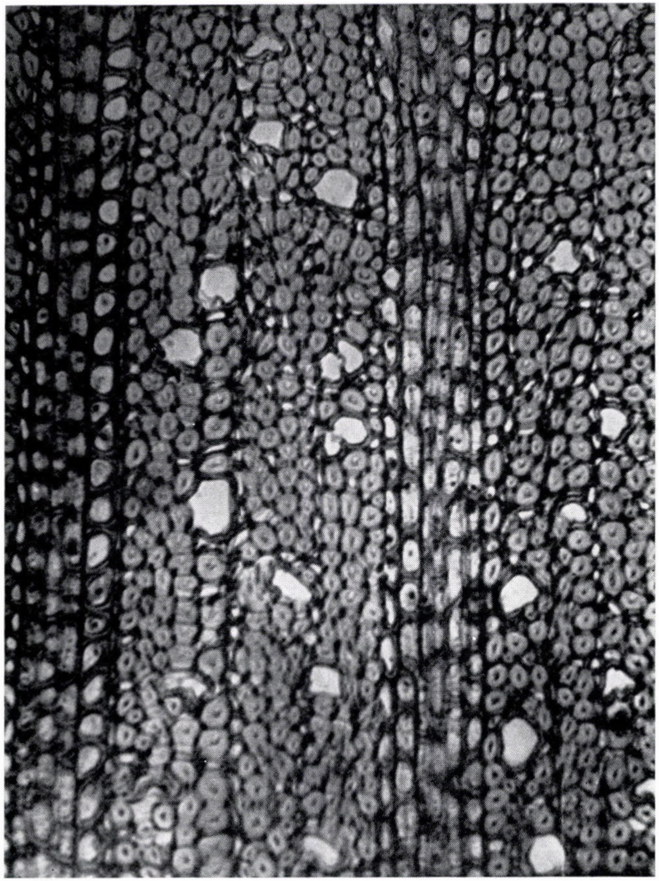

Fig. 1. Garrya fadyenii Hook. Cross section ×120. Small pores, wide medullary rays, fibres with thick wall

Fig. 2. Garrya fadyenii Hook. Radial section ×120. Heterogeneous medullary ray, cells of medullary rays with small crystals. Fibres with thick wall, vessels with scalariform perforation (mark: →)

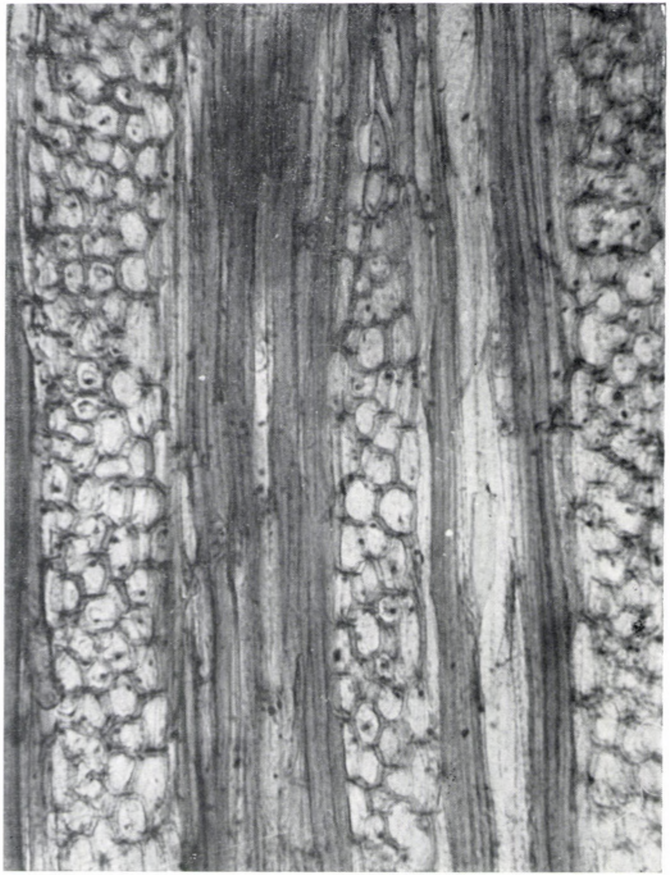

Fig. 3. Garrya fadyenii Hook. Tangential section $\times 120$. Medullary rays two and five cells in width. Fibres with thick wall and trachea

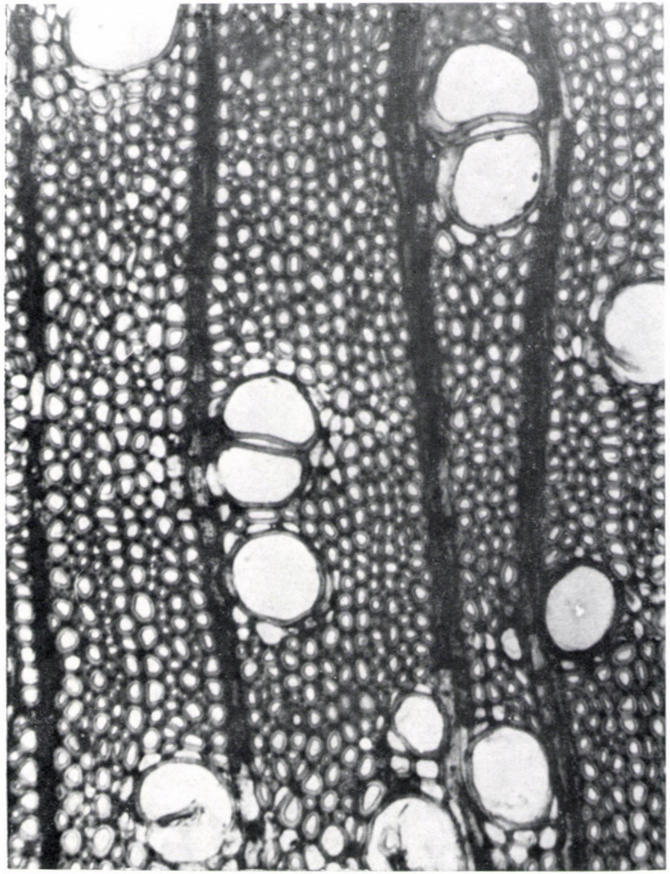

Fig. 4. Catalpa punctata Griseb. Cross section $\times 120$. Medium-sized vessels, medullary rays with one or two cells in width. Fibres with large lumen

Catalpa punctata Griseb.

Wood porous diffuse. The ground mass of the wood is formed by polygonal-shaped fibres with thin wall and wide lumen. Paratracheal vasicentric longitudinal parenchyma. Medullary rays with one or more cells in width (Fig. 4). The solitary tracheae are oval-shaped; tracheae forming groups of 2—4 members with irregular direction are flattened in radial direction. Number is 24 per 1 sq. millimeter. Medium sizes. Tangential diameter 23.0—119.6 μ. Radial diameter 284.0—852.0 μ. Length of the vessel members is 284.0—852.0μ, with oblong bordered pits on the wall. Simple perforation plate. Heterogeneous medullary rays 1—2 cells in width. Height 83.7—306.9 μ. Width 9.3—32.5 μ. The medullary ray cells contain mastic material, and square or polygonal-shaped crystals (Figs 5 and 6). Fibres are in radial lines or in irregular arrangement. Cellular structure. Diameter 16.1—25.3 μ. Constant wall thickness 9.2 μ. Full length 639.0—1491.0 μ. Tips of the fibres smooth, ending in a peak, or one side with saw-teeth. Diameter of the longitudinal parenchyma cells 9.2—25.3 μ. Height 41.8—241.8 μ. Number of the vasicentrical cells 1—3. Cells contain mastic material.

Tabebuia lepidota (H.B.K.) Britt

Wood porous diffuse. The ground mass of the wood is formed by fibres of thick wall and longitudinal parenchyma. Paratracheal-aliform confluent longitudinal parenchyma. Medullary rays mostly one, very rarely two cells in width (Fig. 7).

Rare solitary vessels with roundish shape. Generally arranged in radial or irregular groups of 2—4 members, with oval shape. Number is 47 per 1 sq. millimeter. Sizes are a little greater than those of the *Catalpa*. Tangential diameter 25.3—92.0 μ. Radial diameter 34.5—96.6 μ. Vessel members are 213.0—426.0 μ long with oblong bordered pitting on their wall. Simple perforation plate. Medullary rays with one or very rarely two cells in width. Homogeneous structure. Height 32.5—167.4 μ. Width 4.6—32.5 μ. Cells of medullary rays rarely contain mastic material (Figs 8 and 9).

Fibres in radial lines or in irregular arrangement. Diameter 11.5—13.8 μ. Wall thickness 6.3—9.9 μ. Full length 497.0—1136.0 μ. Tips of fibres ending in a smooth peak, rarely with saw-teeth on one side.

Diameter of longitudinal parenchyma cells 9.2—29.9 μ. Height 32.5—172.0 μ. Strands of longitudinal parenchyma with 3—6 cells in width.

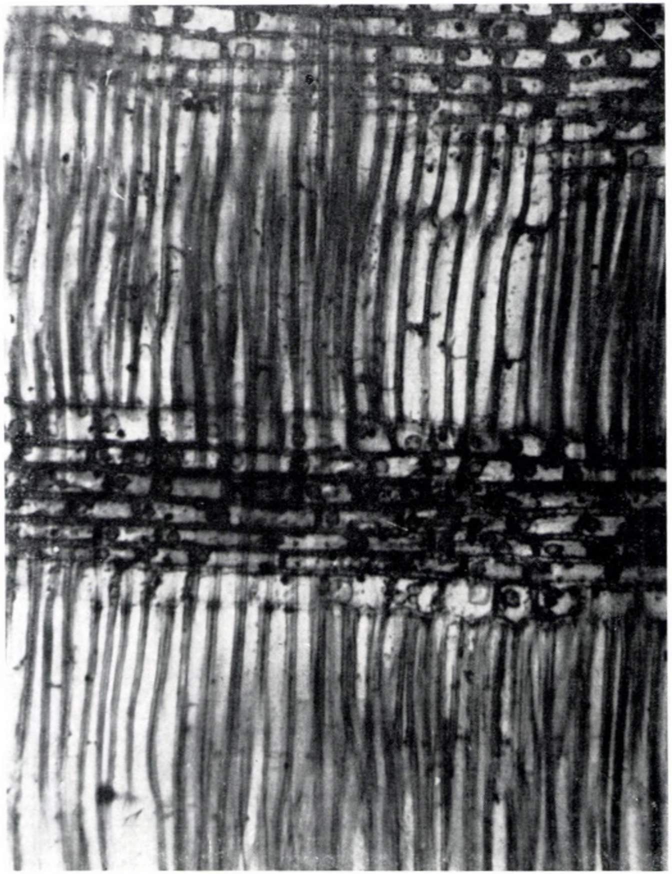

Fig. 5. Catalpa punctata Griseb. Radial section $\times 120$. Heterogeneous medullary rays. Cells of medullary rays with mastic and crystal. Cellular fibres

Fig. 6. Catalpa punctata Griseb. Tangential section $\times 120$. Medullary rays with one or two cells in width. Longitudinal parenchyma, cellular fibres. The bordered pits are distinctly visible on the wall of the vessels

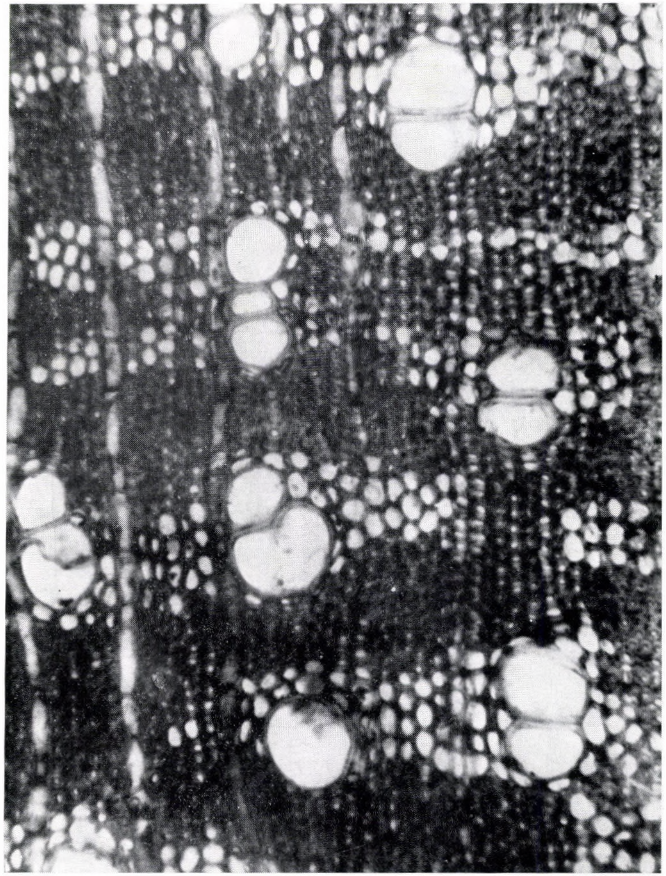

Fig. 7. Tabebuia lepidota (H.B.K.) Britt. Cross section ×120. Medium-sized vessels with relatively thick wall. Medullary rays with one cell in width, fibres of medium thickness, strands of longitudinal parenchyma

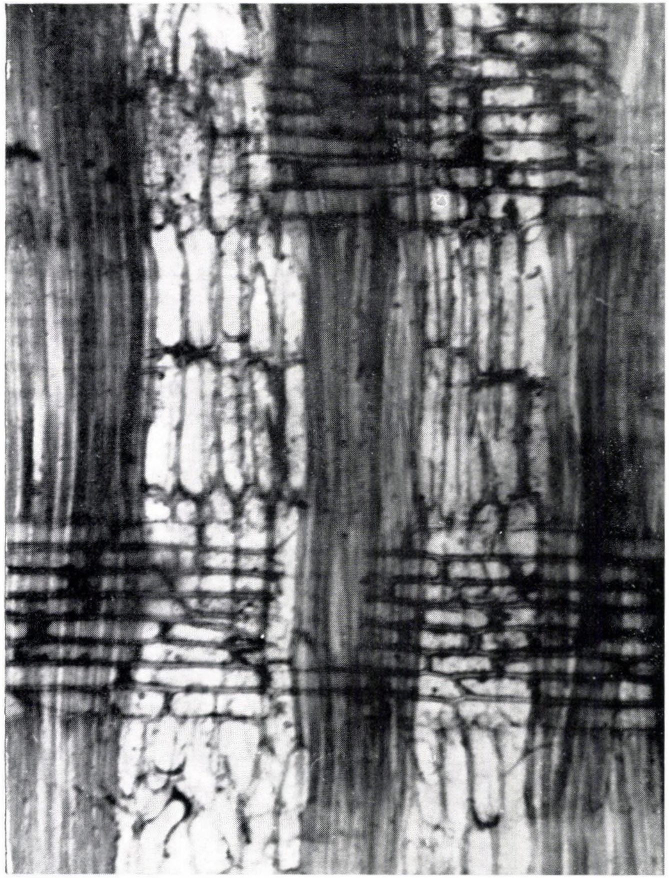

Fig. 8. Tabebuia lepidota (H.B.K.) Britt. Radial section ×120. Homogeneous medullary rays, cells of medullary rays with a small quantity of mastic. Longitudinal parenchyma and fibres

Fig. 9. Tabebuia lepidota (H.B.K.) Britt. Tangential section ×120. Uni- and twoseriate medullary rays. Longitudinal parenchyma and fibres. Small bordered pits on the wall of vessels

Fig. 10. Pera bumeliaefolia Griseb. Cross section ×120. Large-sized vessels with thick wall and gummy material. Uniseriate medullary rays, fibres and longitudinal parenchyma

Pera bumeliaefolia Griseb.

Wood porous diffuse. The ground mass of the wood is formed by polygonal-shaped fibres. Diffuse-apotracheal and metatracheal-continuous longitudinal parenchyma. Medullary rays one or very rarely with two cells in width (Fig. 10). Oval-shaped tracheae, solitary or arranged in radial lines of 2—6 members, with medium or large sizes. Number is 7 per 1 sq. millimeter.

Tangential diameter 46.0—184.0 μ. Radial diameter 68.5—264.0 μ. Vessel members are 781.0—1065.0 μ long, with bordered pitting on their wall. Simple perforation plate. Vessels contain gummy material.

Medullary rays with one or very rarely two cells in width, with heterogeneous structure, more (2—3) marginal cell series. Height 115.0—851.0 μ. Width 11.5—34.5 μ. Cells of medullary rays contain gummy material and small, polygonal-shaped crystals (Figs 11 and 13). Fibres arranged in radial lines. Diameter 9.2—18.4 μ. Wall thickness 4.6—9.2 μ. Full length 1278.0—2201.0 μ. Tips of fibres ending in a smooth peak, or with saw-teeth on one side. Diameter of longitudinal parenchyma cells 11.5—25.3 μ. Height 65.1—437.1 μ. Cells contain mastic or gummy material. It is necessary to mention the cellular crystal holder parenchyma (part of Fig. 12 marked with →).

Trichilia hirta L.

Wood porous diffuse; the ground mass of the wood is formed by polygonal shaped fibres with thick wall and narrow lumen. Paratracheal aliform-confluent longitudinal parenchyma. Medullary rays with one or two cells in width (Fig. 14).

Tracheae are roundish or oval-shaped with small sizes, containing mastic material. Their number is 39 per 1 sq. millimeter. Tangential diameter 36.8—71.3 μ. Radial diameter 46.0—96.6 μ. Vessel members are 355.0—923.0 μ long; on their wall there are some adorned bordered pits in alternative positions. Perforation plate is simple. Heterogeneous medullary rays 1—2 cells in width. Height 57.5—1115.5 μ. Width 11.5—34.5 μ. Cells of the medullary rays contain polygonal-shaped crystals (Figs 15—16).

Fibres are commonly ordered in radial lines. Diameter 9.2—18.4 μ. Thickness of wall 6.9—11.5 μ. Full length 710.0—1491.0 μ. Tips of the fibres commonly ending in a peak, one side with saw-teeth. Diameter of the longitudinal parenchyma cells 9.3—27.9 μ. Height 51.1—190.6 μ. Cellular crystal holder longitudinal parenchyma occurs frequently.

Fig. 11. Pera bumeliaefolia Griseb. Radial section ×120. Heterogeneous medullary ray, longitudinal parenchyma and fibres. Within the cells of medullary rays and longitudinal parenchyma gum or mastic

Fig. 12. Pera bumeliaefolia Griseb. Radial section ×120. Crystal holder — longitudinal parenchyma (mark: →)

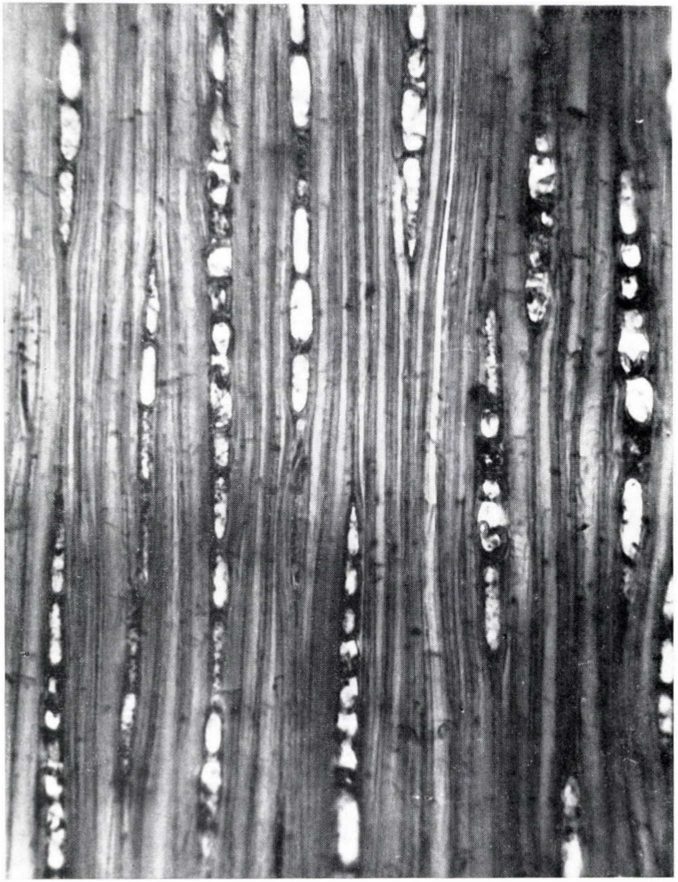

Fig. 13. Pera bumeliaefolia Griseb. Tangential section ×120. Medullary rays with one cell in width, within the cells mastic or gum, and fibres

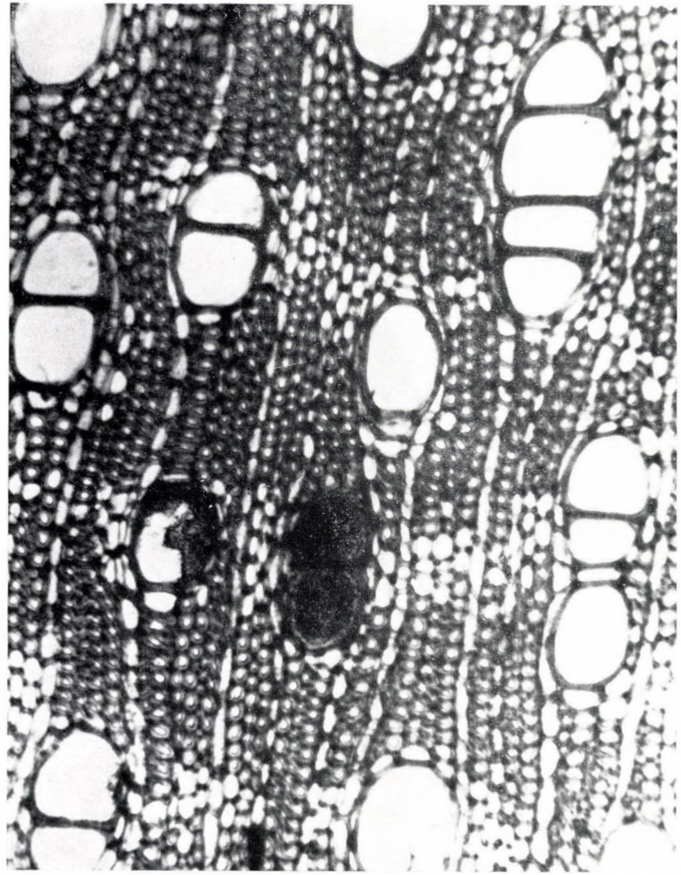

Fig. 14. Trichilia hirta L. Cross section ×120. Tracheae of small size. Tracheae contain mastic material. Narrow medullary rays, thick wall of fibres

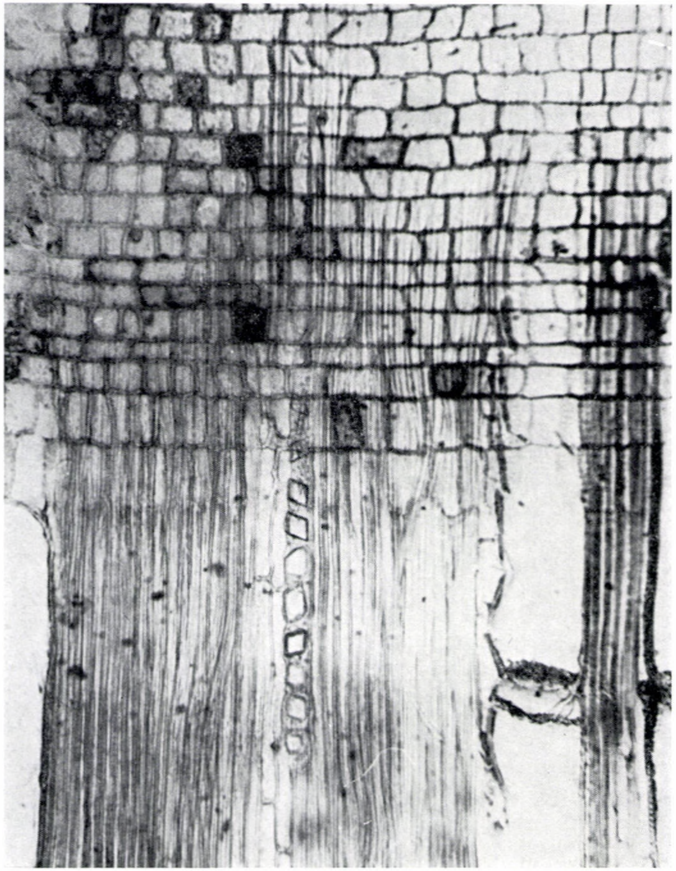

Fig. 15. Trichilia hirta L. Radial section ×120. Heterogeneous medullary ray; cells of medullary ray contain crystals of polygonal shape. Fibres of thick wall and cellular crystal holder longitudinal parenchyma

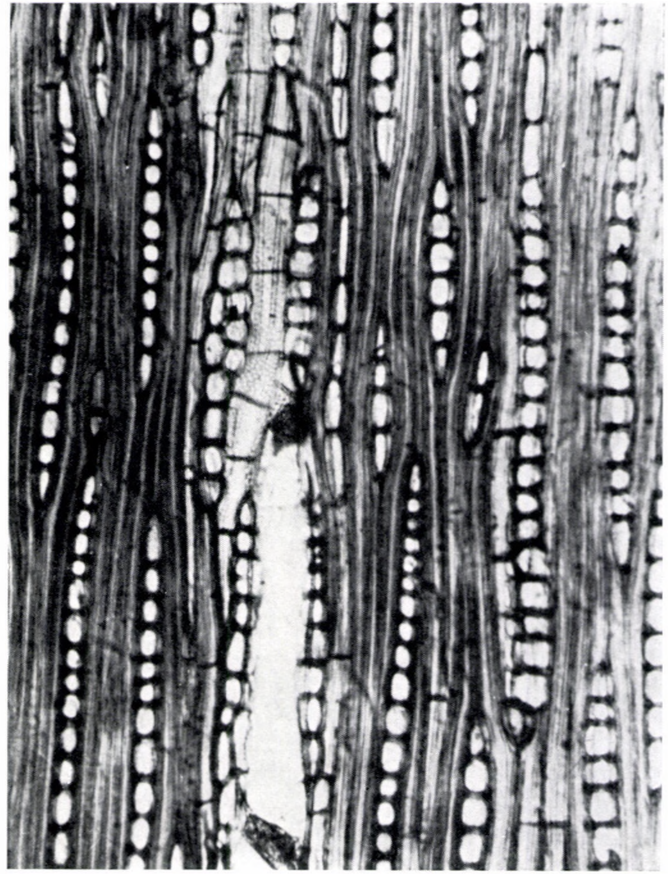

Fig. 16. Trichilia hirta L. Tangential section ×120. Medullary rays of one cell in width. Fibres and trachea of thick wall

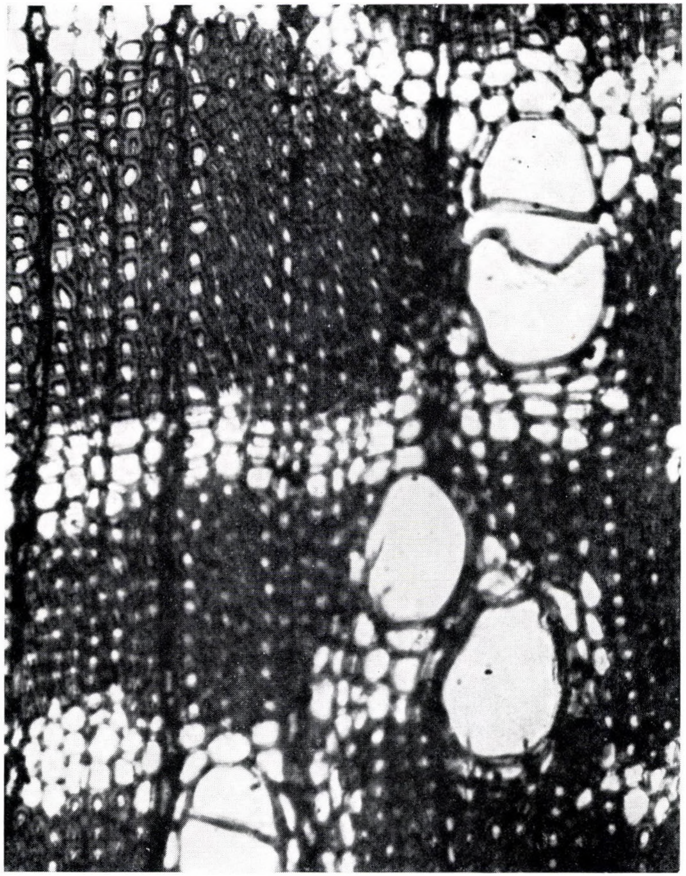

Fig. 17. Guarea Guidonia (L.) Sleumer. Cross section ×120 Large tracheae, medullary rays of one or two cells in width and longitudinal parenchyma. Small lumen of fibres

Fig. 18. Guarea Guidonia (L.) Sleumer. Radial section 120×. Heterogeneous medullary rays; cells of medullary rays contain mastic material. Longitudinal parenchyma and fibres of thick wall

Fig. 19. Guarea Guidonia (L.) Sleumer. Tangential section ×120. Medullary rays of one cell in width and fibres of thick wall. Cells of medullary rays contain mastic material

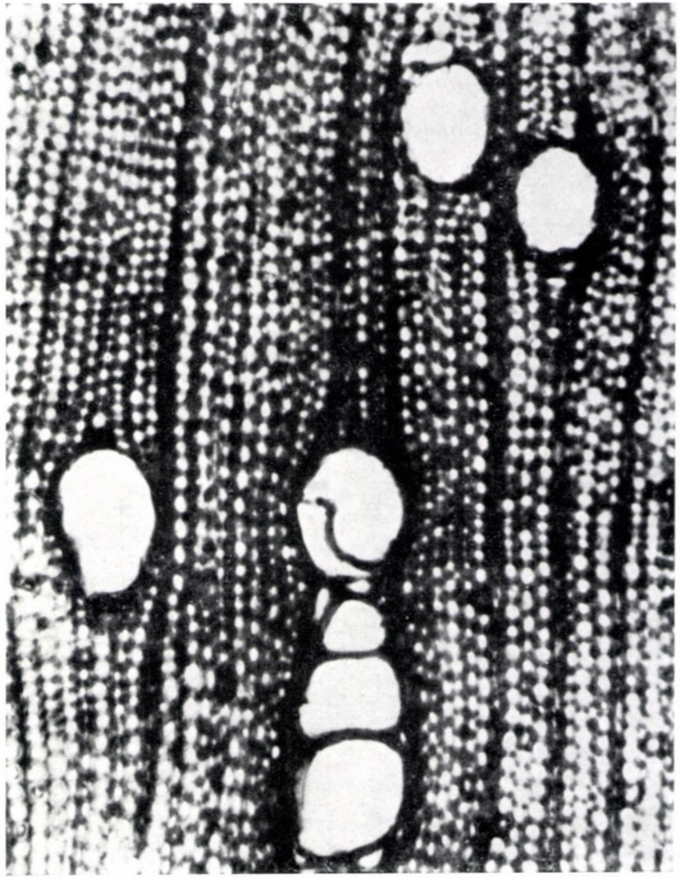

Fig. 20. Cupania glabra Sw. Cross section ×120. Tracheae of small size, narrow medullary rays. Vasicentric-contact longitudinal parenchyma. Thin wall of fibres

Guarea Guidonia (L.) Sleumer

Wood porous diffuse. The ground mass of the wood is formed by fibres with thick wall and narrow lumen and by longitudinal parenchyma. Paratracheal aliform-confluent longitudinal parenchyma. (JANE 1956). Medullary rays with one or rarely two cells in width (Fig. 17). The solitary or double tracheae are oval-shaped. They can rarely form groups of 3—4 members with irregular direction; in this case tracheae are flattened in radial direction. Number is 9 per 1 sq. millimeter.

Sizes are large. Tangential diameter 64.4—165.6 μ. Radial diameter 57.5—209.3 μ. Length of the vessel members is 149.5—805.0 μ, with oblong bordered pits on the wall. Simple perforation plate. Heterogeneous medullary rays 1, rarely 2 cells in width. Height 92.0—575.0 μ. Width 11.5—34.5 μ. Medullary rays contain mastic material (Figs 18—19).

Fibres are in radial lines or in irregular arrangement. Structure is rarely cellular. Diameter 13.8—27.6 μ. Wall thickness 9.2—13.8 μ.

Full length 852.0—2485.0 μ. Tips of the fibres smooth, ending in a peak.

Diameter of the longitudinal parenchyma cells 13.9—41.8 μ. Height 79.0—190.6 μ. Zones of longitudinal parenchyma with 2—4 cells in width. The cellular crystal holder longitudinal parenchyma occurs more rarely than in the *Trichilia.*

Cupania glabra Sw.

Wood porous diffuse. The ground mass of the wood is formed by fibres with thin wall and wide lumen. Paratracheal vasicentric contact longitudinal parenchyma. (WAGENFÜHR and SCHEIBER 1974). Medullary rays mostly with one or very rarely with two cells in width (Fig. 20).

Tracheae are solitary or arranged in lines of 2—5 members, in radial direction, with a mildly oval shape. Number is 18 per 1 sq. millimeter. Small sizes. Tangential diameter 23.0—108.1 μ. Radial diameter 23.0—121.9. Vessel members are 568.0—1136.0 μ long, with a lot of small bordered pits on their wall. Simple perforation plate.

Medullary rays with one or very rarely two cells in width. Homogeneous structure. Height 41.8—1126.5 μ. Width 9.3—27.9 μ. Medullary rays'cells contain mastic materials (Figs 21, 22, 23).

Fibres are arranged in radial lines. Diameter 13.8—25.3 μ. Wall thickness is 3.5—9.2 μ; cellular structure. Full length 71.0—1420.0 μ. Tips of the fibres end in a smooth peak.

Diameter of the longitudinal parenchyma cells is 9.3—7.9 μ. Height 60.4—181.3 μ. Number of the vasicentric-contact cells is 1—2. The cells contain mastic materials. Between the fibres there are some cellular crystal holder longitudinal parenchyma zones.

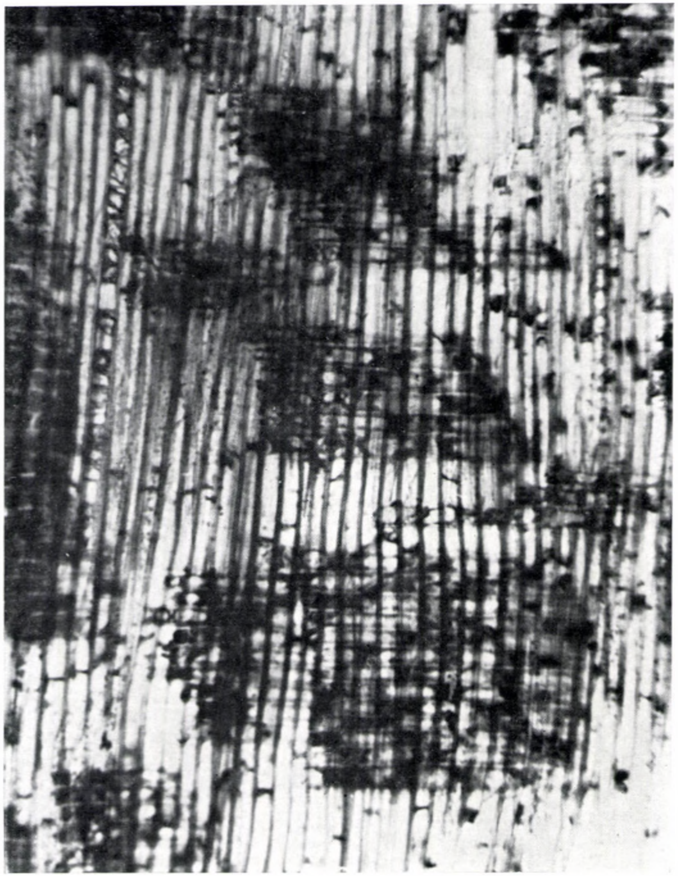

Fig. 21. Cupania glabra Sw. Radial section ×120. Homogeneous medullary rays. Cells of medullary rays contain mastic material. Cellular fibres. Crystal holder longitudinal parenchyma

Fig. 22. Cupania glabra Sw. Tangential section ×120. Medullary rays of one or two cells in width. Cells of the medullary rays contain mastic material. Fibres of thin wall

Fig. 23. Cupania glabra Sw. Tangential section $\times 120$. Medullary rays of one cell in width. Cells of medullary rays contain mastic material. A lot of small bordered pits on the wall of tracheae; simple perforation plate

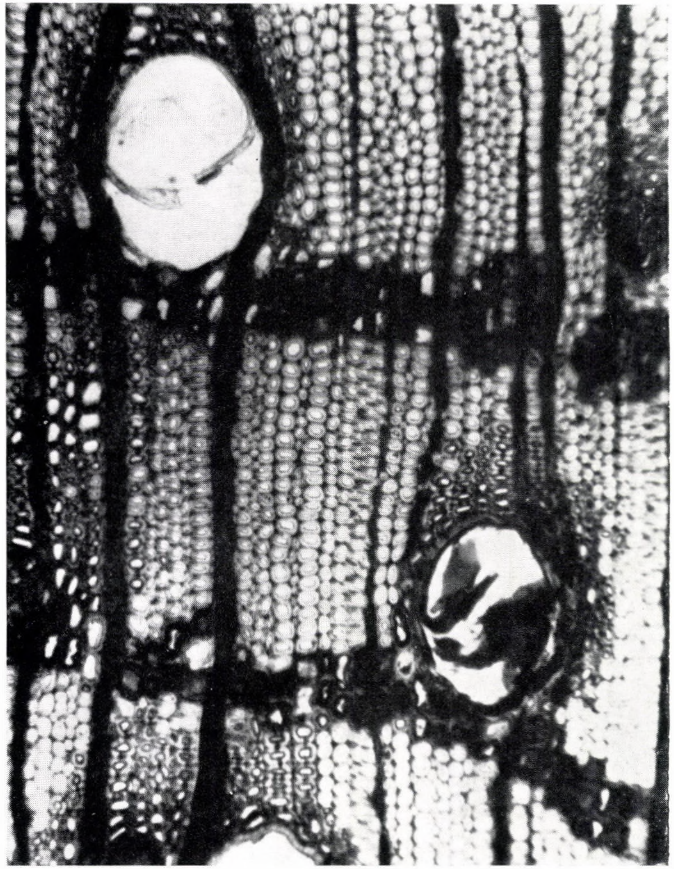

Fig. 24. Calophyllum antillanum Britt. Cross section $\times 120$. Tracheae of large size. Medullary rays of one or two cells in width. Apotracheal and vasicentric contact longitudinal parenchyma cells of parenchyma filled with gummy material. Fibres and fibre-tracheids

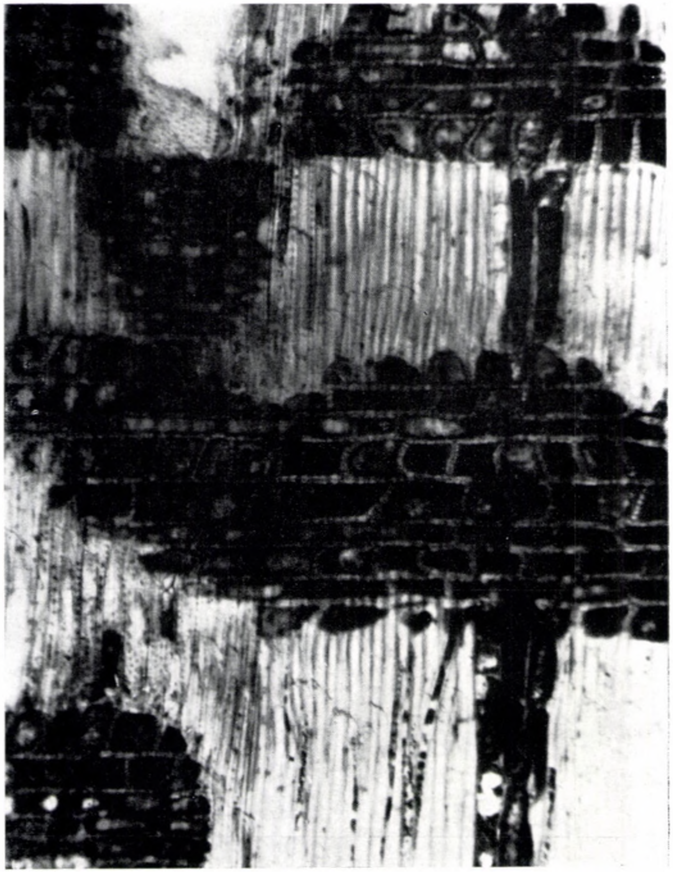

Fig. 25. Calophyllum antillanum Britt. Radial section ×120. Heterogeneous medullary rays. Cells of medullary rays contain gummy material. Fibres of thick wall

Fig. 26. Calophyllum antillanum Britt. Tangential section ×120. Medullary rays of one or two cells in width, with cumulated arrangement. Cells of medullary rays contain gummy material. Longitudinal parenchyma. Simple and bordered pits distinctly visible on the wall of fibres

Calophyllum antillanum Britt.

Wood porous diffuse. The ground mass of the wood is formed by fibres and fibre-tracheids. Apotracheal and vasicentric-contact longitudinal parenchyma. Medullary rays are one or two cells in width (Fig. 24). Tracheae are oval-shaped. They are solitary, but rarely form irregular groups of 2—4 members; large sizes. Their number is 9 per 1 sq. millimeter. Tangential diameter 52.9—163.3 μ; radial diameter 50.6—234.6 μ. The vessel members are 426.0—1065.0 μ long with a lot of small bordered pits on their wall. Simple perforation plates. The vessels contain mastic material.

Medullary rays 1—2 cells in width, with cumulated arrangement and heterogeneous structure. Height 92.0—494.5 μ. Width 11.5—34.5 μ. Cells of the medullary rays contain gummy-material (Figs 25, 26).

Fibres are arranged in radial lines. Diameter 11.5—20.7 μ. Wall thickness 6.9—11.5 μ. Full length 852.07—1704.0 μ. On the radial wall of the fibres there is a bordered or simple pit of small size. Tips of the fibres end in a smooth peak, rarely forking.

Diameter of the longitudinal parenchyma cells is 13.9—27.9 μ. Height 46.5—209.2 μ. Cells contain mastic or gummy-material. Cellular crystal holder longitudinal parenchyma does not occur frequently. Detailed anatomical features of the species are shown in Tables 1, 2.

Table 1

Detailed anatomical features of the species

Wood element	Features	*Garrya fadyenii*	*Catalpa punctata*
Vessel members	Arrangement	diffuse-solitary	diffuse-solitary or irregular group of 2—4 members
	Shape	oval — very small	oval or flattened
	Tangential diameter	18.4—52.9 μ	23.0—119.6 μ
	Radial diameter	23.0—57.5 μ	29.9— 85.1 μ
	Wall thickness	2.3— 4.6 μ	2.3— 4.6 μ
	Length of vessel members	355.0—1065.0 μ	284.0—852.0 μ
	Number per sq. mm	69	24
	Intervascular pitting	bordered-rare	bordered-oblong
	Perforation plate	scalariform	simple
	Content	—	—
Medullary rays	Width	uni- to multiseriate	uni- to twoseriate
	Number of cells	1—5	1—2
	Classification	heterogeneous	heterogenous
	Height	230.0—4830.0 μ	83.7—306.9 μ
	Width	23.0— 115.0 μ	9.3— 32.5 μ
	Content of cells	polygonal-shaped small crystals	numerous small polygonal-shaped crystals and mastic

Continued table 1

Wood element	Features	*Garrya fadyenii*	*Catalpa punctata*
Fibres	Arrangement Shape Full diameter Wall thickness Full length Type of pitting	radial polygonal 16.1— 25.3 μ 10.7— 11.5 μ 781.0—1633.0 μ bordered	radial or irregular polygonal-cellular 16.1— 25.3 μ 9.2 639.0—1491.0 μ simple
Longi-tudinal paren-chyma	Arrangement Diameter Height Number of cells Content Other	Apotracheal-diffuse 6.9— 23.0 μ 51.1—265.0 μ 1 — —	paratracheal-vasicentric 9.2— 25.3 μ 41.8—241.8 μ 1 — 3 mastic —
Wood element	Features	*Tabebuia lepidota*	*Pera bumeliaefelia*
Vessel members	Arrangement Shape Tangential diameter Radial diameter Wall thickness Length of vessel member Number per sq. mm Intervascular pitting Perforation plate Content	diffuse-solitary or in radial lines of 2—4 members roundish or oval 25.3— 92.0 μ 34.5— 96.6 μ 2.3— 6.9 μ 213.0— 426.0 μ 47 bordered-oblong simple —	diffuse-solitary or in radial lines of 2—6 members oval 46.0— 184.0 μ 68.5— 264.0 μ 4.6— 11.5 μ 781.0—1065.0 μ 7 bordered simple gum
Medullary rays	Width Number of cells Classification Height Width Content of cells	uni- or very rarely twoseriate 1—2 homogeneous 32.5— 167.4 μ 4.6— 32.5 μ mastic	uni- or very rarely twoseriate 1—2 heterogeneous 115.0— 851.0 μ 11.5— 34.5 μ gum and crystals
Fibres	Arrangement Shape Full length Wall thickness Full length Type of pitting	radial or irregular polygonal 11.5— 13.8 μ 6.3— 9.9 μ 497.0—1136.0 μ simple	radial polygonal 9.2— 18.4 μ 4.6— 9.2 μ 1278.0—2201.0 μ bordered-flanged
Longi-tudinal paren-chyma	Arrangement Diameter Height Number of cells Content Other	paratracheal-aliform confluent 9.2— 29.9 μ 32.5— 172.0 μ 3—6 — —	apotracheal-diffuse meta-tracheal continuous 11.5— 25.3 μ 65.1— 437.1 μ 1—2 gum or mastic cellular crystal holder parenchyma

Table 2

Detailed anatomical features of the species

Wood element	Features	*Trichilia hirta*	*Guarea Guidonia*
Trachea members	Arrangement	diffuse solitary or radial groups of 2—5 members	diffuse solitary or double
	Shape	roundish or oval	oval
	Tangential diameter	36.8— 71.3 μ	64.4— 165.6 μ
	Radial diameter	46.0— 96.6 μ	57.5— 209.3 μ
	Wall thickness	2.3— 6.9 μ	2.3— 9.2 μ
	Length of vessel members	355.0— 923.0 μ	149.5— 805.0 μ
	Number per 1 sq. mm	39	9
	Intervascular pitting	adorned-bordered	oblong-bordered
	Perforation plate	simple	simple
	Content	mastic	—
Medullary rays	Width	uni- or biseriate	uni- or biseriate
	Number of cells	1—2	1—2
	Classification	heterogeneous	heterogeneous
	Height	57.5—1115.5 μ	92.0— 575.0 μ
	Width	11.5— 34.5 μ	11.5— 34.5 μ
	Content of cells	—	mastic
Fibres	Arrangement	radial	radial or irregular
	Shape	polygonal	polygonal
	Full diameter	9.2— 18.4 μ	13.8— 27.6 μ
	Wall thickness	6.9— 11.5 μ	9.2— 13.8 μ
	Full length	710.0—1491.0 μ	852.0—2485.0 μ
	Type of pit	simple	simple
Longitudinal parenchyma	Arrangement	paratracheal aliform-confluent	paratracheal aliform confluent
	Diameter	9.3— 27.9 μ	13.9— 41.8 μ
	Height	51.1— 190.6 μ	79.0— 190.6 μ
	Number of cells	1—3	2—4
	Other	cellular crystal holder parenchyma	cellular crystal holder parenchyma

Wood element	Features	*Cupania glabra*	*Colophyllum antillanum*
Trachea members	Arrangement	diffuse solitary or radial groups of 2—5 members	diffuse, solitary or irregular groups of 2—4 members
	Shape	oval	oval
	Tangential diameter	23.0— 108.1 μ	52.9— 163.3 μ
	Radial diameter	23.0— 121.9 μ	50.6— 234.6 μ
	Wall thickness	2.3— 6.9 μ	2.3— 6.9 μ
	Length of vessel members	568.0—1136.0 μ	426.0—1065.0 μ
	Number per 1 sq. mm	18	9
	Intervascular pitting	bordered	bordered, small
	Perforation plate	simple	simple
	Content	—	mastic

Table 2, Continued

Wood elements	Features	*Cupania glabra*	*Calophyllum antillanum*
Medullary rays	Width	uni- or biseriate	one, rarely two, cumlated ray
	Number of cells	1—2	1—2
	Classification	homogeneous	heterogeneous
	Height	41.8—1162.5 μ	92.0— 494.5 μ
	Width	9.3— 27.9 μ	11.5— 34.5 μ
	Content of cells	mastic	mastic
Fibres	Arrangement	radial	radial or irreg.
	Shape	polygonal	polygonal
	Full diameter	13.8— 25.3 μ	11.5— 20.7 μ
	Wall thickness	3.5— 9.2 μ	6.9— 11.5 μ
	Full length	710.0—1420.0 μ	852.0—1704.0 u
	Type of pits	simple	bordered
Longitudinal parenchyma	Arrangement	vasicentric-contact	apotracheal-vasicentric-contact
	Diameter	9.3— 27.9 μ	13.9— 27.9 μ
	Height	60.4— 181.3 μ	46.5— 209.2 μ
	Number of cells	1—2	1—6
	Content	mastic	gummy
	Other	cellular crystal holder parenchyma	cellular crystal holder parenchyma

Origin of the samples

Garrya fadyenii Hook.: Cuba; Prov. Oriente; Sierra Maestra: Pico Marti in altit. of 1300 m. Collected by A. Borhidi and M. Vales, 12. 1. 1976.

Catalpa punctata Griseb. ssp. *punctata:* Cuba; Prov. Pinar del Rio; Peninsule of Guanahacabibes, El Veral Nature Conserv. Area, in alt. 5—10 m. Collected by A. Borhidi and M. Vales, 14. 12. 1974.

Tabebuia lepidota (HBK.) Britt.: Cuba; Prov. Matanzas, Canasi; Collected by M. Vales, 6. 11. 1974.

Pera bumeliaefolia Griseb.: Cuba; Prov. Camagüey; Sierra de Cubitas, Loma Tuabaquey in altit. approx. 300 m. Collected by M. Vales, 8. 5. 1975.

Trichilia hirta L.: Cuba; Prov. La Habana; Loma de Perle, Jibacoa, in altit. approx. 100 m. Collected by M. Vales, 29. 10. 1974.

Guarea Guidonia (L.) Sleumer: Cuba; Prov. Pinar del Rio; Sierra del Rosario; Loma El Salón, in altit. approx. 450 m. Collected by M. Vales, 19. 11. 1974.

Cupania glabra Sw.: Cuba; Prov. La Habana; Escaleras de Jaruco in altit. approx. 200 m. Collected by M. Vales, 9. 10. 1974.

Calophyllum antillanum Britt.: Cuba; Prov. Pinar del Rio; Sierra del Rosario, Loma El Salón, in altit. approx. 470 m. Collected by M. Vales, 20. 11. 1974.

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ECOLOGICAL FACTORS—ADAPTABILITY-RELATIONSHIP OF STEROID ALKALOID PRODUCTION BASED ON INVESTIGATION OF EXAMEN TWO SPECIES, *SOLANUM LACINIATUM* AIT. AND *SOLANUM DULCAMARA* L.

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As a result of investigations carried out over ten years in a phytotron, culture vessel, under micro and small plot field conditions the formation and accumulation of secondary plant products is elucidated from a new point of view. According to the authors even with a homologous formation of identical secondary material (in the given case: steroid alkaloid), the species under examination as well as its ecological adaptability must be taken into consideration, and the variations must be evaluated in a complex way by simultaneously following the changes in growth and development. For the changes in the total alkaloid production can take place depending on the species; directly, through the changes in the active agent levels in the organs, with the changes in the ratio of production of the organ having various active agent levels and by influencing the total dry matter production (in the case of partly unchanged active agent levels and organ ratios). The greater differences in alkaloid production are shown by the heliophyton species, *S. laciniatum*, which is less adaptive even morpho-phenologically. Thus, in comparison with the ubicuous *S. dulcamara*, the formation of aglycon (solasodine), depending on the light intensity, is 10—12 times higher, and again depending on air temperature, water-, soil and nutrient supply, it shows a 50—100% deviation. In accordance with this, it is more reasonable if instead of speaking about a general ecological factor—alkaloid production effects, we deal with the changes in the ecological factor—alkaloid type and in primary reaction—alkaloid production depending on the ecotype.

Introduction

During the past years, parallel with the investigations into the occurrences and distribution of steroids, the examinations into their biosynthesis led to considerable results. The number of publications on the effect of environmental factors on the formation of secondary materials also increased considerably until the mid fifties (FLÜCK 1954, 1955; NOWINSKY 1956), although the results were sometimes contradictory with the past two decades for the modern methods of ecological research have established the conditions of exact investigations also in this field.

In our present work, we wish to provide the synthesis of the series of the experiments over some ten years, the aim of which was to determine the conditions of steroid alkaloid formation in two plant species—*Solanum laciniatum* and *S. dulcamara*. In addition to the great economic importance of the

compound group developing in these species (Birmingham, *Solanaceae* Congress, 1976), the ecological investigations carried out parallelly on these two species are also extremely interesting for *S. laciniatum* originates from Australia and New-Zealand, while *S. dulcamara* is a plant of the holarctic floral kingdom. Considering their habitat, the former species grows in sunny, open stands, and the latter under varying conditions, but primarily in closed stands.

In spite of the differences in their distributions and so in their ecological demands the species contain partly identical steroid glycoalkaloids. The main glycoalkaloids of *S. laciniatum* and of *S. dulcamara* are solamargine and solasonine (its aglycon is solasodine); besides this, in respect to *S. dulcamara*, the presence of soladulcamarine, α, β, Γ-solamarine (its aglycon is tomatidenol), soladulcine, soladulcine-tetrazoid (its aglycon is soladulcine) is also characteristic. This provided a way of studying the effect of ecological factors on the production of steroid alkaloids in plants of differing ecological demands by supposing the homologous biosynthetic pathways (VÁGÚJFALVI 1968). At the same time, our aim was also to determine factors that influence the production of active agents in both plant species in an identical way, and which one in a different way, depending on their ecological demands.

Materials and methods

The similarities and dissimilarities in dry matter and active agent production depending on species, were studied by an exact investigation of the individual factors. During the ten years of the experimental series, we applied partly parallel examinations, partly interdependent ones carried out in phytotron, in culture vessels, in field experiments of microparcels as well as in a system of small parcels. The following publications contain the detailed description of the methods: BERNÁTH 1970, 1971; BERNÁTH and FÖLDESI 1969, 1972a, b, 1974; BERNÁTH and TÉTÉNYI 1973; BERNÁTH et al., 1976.

We aimed to ensure that a homogeneous plant material be available both morphologically and with respect to its chemism. The seed material of the species designated 'determined', was produced with radiation treatment from *S. laciniatum* 'Budakalászi' of normal growth. The morpho-phenological dissimilarities of the seeds, and the similarities of their chemism have been proved by several publications (SZABADY and TÉTÉNYI 1972, 1974). In the *S. dulcamara* species — because of the considerable morpho-phenological differentiation in its morphology (MÁTHÉ, jr. 1974; VO HONG NGA, 1975) the plant material used had been selected in previous screen tests then prepared in a tissue culture and after organ differentiation, reproduced by cloning. Morpho-phenologically, this material was *S. dulcamara* var. *dulcamara* f. *cordifolium*, with respect to chemism, it was 'tomatidenol + solasodine + soladulcidine', a chemical taxa of mixed aglycon.

The changes that had taken place in the dry matter and active agent production—depending on the character of the experiment—were evaluated partly consecutively by pursuing the growth and partly at the end of the vegetation period. In relation to the active agent, the spirosolanol aglycons will be dealt with. They were checked by the titrimetric method of SZILÁGYI and TÉTÉNYI 1967, and by the layer chromatographic method of ZÁMBÓ and TÉTÉNYI 1976).

Factors influencing the steroid aglycon production

On the basis of our investigations, it can be stated that the ecological factors affect the alkaloid production of plants in three well distinguishable

directions. These effects can play a complex role, but occasionally can also play separately a decisive role. The influencing role may be directed at:

— the level of active agent principles directly,
— the ratio of organs at differing active agent levels,
— the total dry matter production (in partly unchanged active agent levels and organ ratios).

In the discussion which follows the role of environmental factors will be surveyed in the light of the above determing forces having a decisive role on aglycon production.

The effect of ecological factors on the active agent levels of the organs

We have succeeded in proving unequivocally that light (its intensity and spectrum composition) has a decisive influence on the aglycon level of the organs of the species involved in the investigations. The role of the spectrum composition is the most unambiguous (BERNÁTH et al., 1976), since it is effective irrespective of the ecotype of the species, however with respect to its character, it has an identical effect (Fig. 1); the radiation of the short wave band region increases the aglycon level, the direct effect of the light from the short wave band region is manifest also by the fact that, in these light treatments contrary to the literature on stability (MÁTHÉ, jr., 1974) — the qualitative composition of aglycon in *S. dulcamara* changes: the solasodine ratio of unsat-

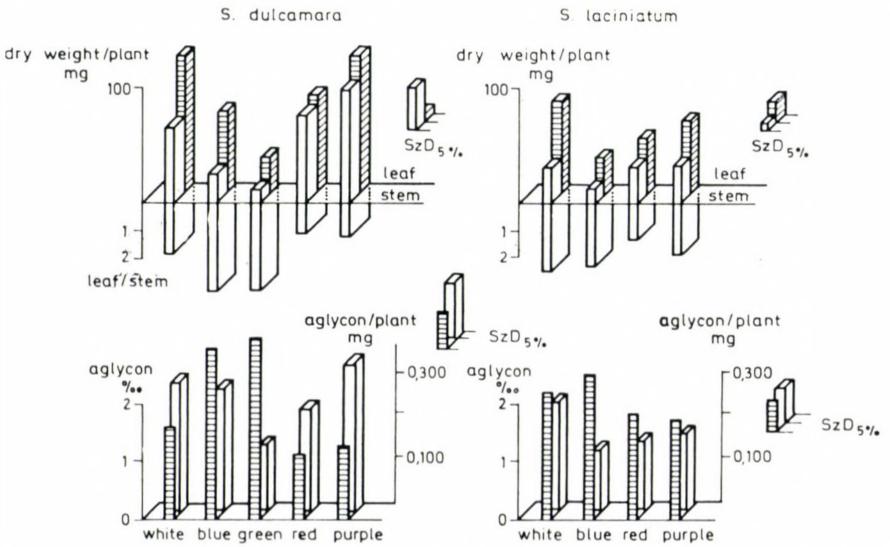

Fig. 1. The effect of the wave range of light on the production of dry matter content and steroid aglycon

urated sterane frame increases simultaneously with a decrease in the soladulcidine quantity. This change provides a basis for proving the supposition (MÁTHÉ and MÁTHÉ, jr., 1973) according to which ecological factors are of significance in the production of chemical taxa.

In opposition to this, the effect of light intensity on the aglycon level definitely depends on the ecological adaptability of the species examined. While at low light intensity (1600 lux), in the heliophyton species — which has lower adaptability to weak light supply — the alkaloid level decreases by nearly an order of magnitude, in the sciophyton plant (*S. dulcamara*) — which adapts itself well — the quantity of alkaloids remains unchanged (Fig. 2). This successful adaptation manifests itself in both the morpho-phenological and the dry matter production values.

Thus, it is more reasonable to deal with the effect of light intensity—alkaloid level, which is dependent on light demand, than with that of light—alkaloid level. Although these two parameters can occasionally have identical meaning, but according to the testification of our investigations, this is not inevitable.

The direct effect of air temperature on the alkaloid level could be clearly detected. This effect, similarly to the role of light intensity, is species-specific, that is the reaction depends on the adaptability of the species. In phytotron, after breeding it at 28 °C (Fig. 3), under the effect of an interval of a temperature block of 10 °C, the quantity of solasodine decreased by 50% in a week in *S. laciniatum*, while in *S. dulcamara* only an extremely high (above 30 °C) temperature caused a decrease in active agent content—parallel with heat damage. The quantitative composition of aglycons is not influenced by the air

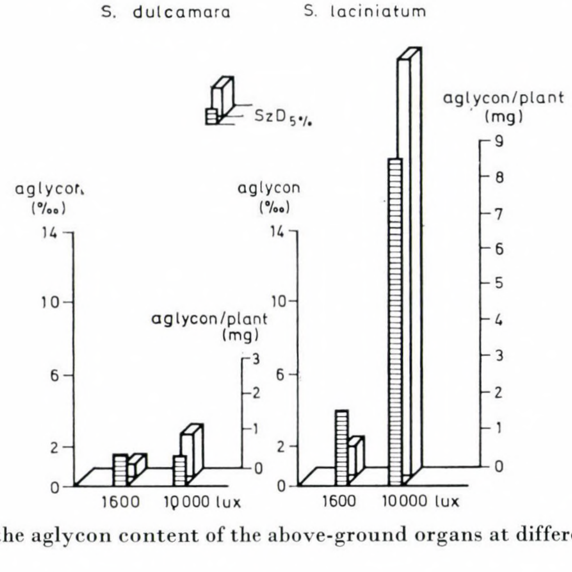

Fig. 2. Changes in the aglycon content of the above-ground organs at different light intensities

temperature. In respect of *S. laciniatum*, we succeeded in proving increased reaction, even under field conditions. The changes in solasodine content according to the breeding period is essentially determined by the temperature conditions (Fig. 4). The correlation coefficient value is r = 0.81 (BERNÁTH—FÖLDESI 1974). The depression at the end of the breeding period is especially significant, which ensues in spite of the continuel flowering of the plants. This dicrease can be stopped or reversed by covering the plant with transparent plastic foil. Under the effect of the surplus temperature which develops under the foil cover, solasodine content can increase even by 3—5‰ (Fig. 5). The connexion between air temperature and solasodine content is significant also from the point of view of practice, moreover besides explaining the low values measured in Hungary in the periods at the end of September and at the beginning of October, it could be a precondition of successful cultivation further on. Since the change in the active agent level to such an extent can take place within a short period (one week), the time of gathering should be determined with due consideration of this circumstance.

The direct effect of the other factors on the alkaloid level could not be testified in any of the investigations. Changes in the alkaloid level did not ensue even under extreme soil nutrient, and water supply conditions, not even when the difference in the total dry matter production attained a level of 200—300%. Not even the connection between water supply and aglycon level observed in the natural vegetation examinations into *S. dulcamara* can be considered as such an effect. The minimum level of active agent in the middle of the breeding period (which is in agreement with the examination results of MÁTHÉ, jr. and MÁTHÉ, 1974) can be attributed to the aging processes emerg-

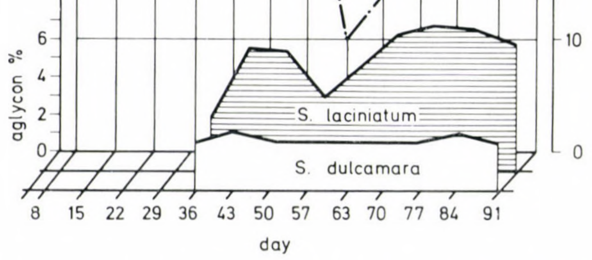

Fig. 3. Quantitative changes in the steroid aglycons depending on air temperature, in phytotron

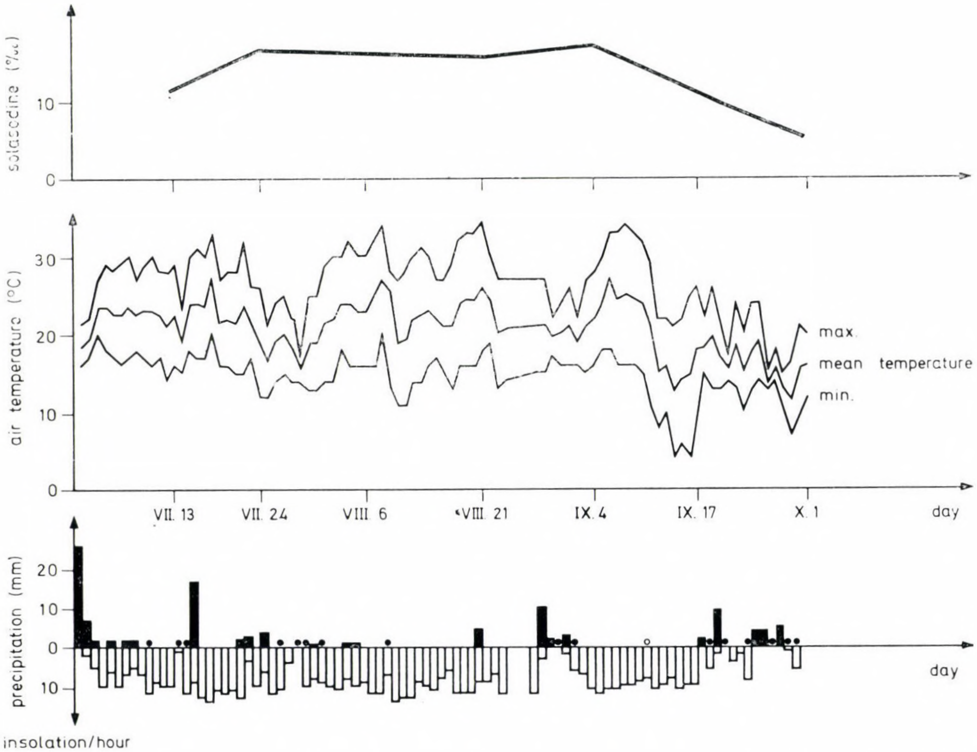

Fig. 4. Changes in the aglycon content of the leaf in *Solanum laciniatum*, and of the main meteorological factors, as a function of breeding time in Budakalász (1973)

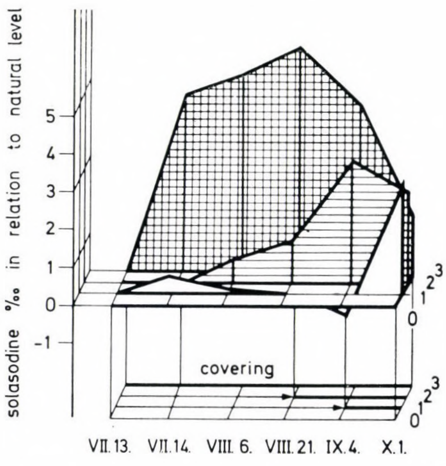

Fig. 5. The increase in the aglycon content of the leaf of *Solanum laciniatum*, under the effect of the surplus air temperature prevailing under the folia cover (1973)

(∅) the basis of comparison in natural conditions for the solasodine content;
(1) coverage of the plants at the flowering time of the fifth node level, on 4th November;
(2) coverage of the plants at the flowering time of the fourth node level, on 21st August;
(3) coverage of the plants at the flowering of the second node level, on 13th July

ing simultaneously with the ceasing of growth under conditions lacking precipitation. This is confirmed by the fact that the leaves re-shooting during August–September show an increase in aglycon content, and such morphological characteristics as occur at the beginning of the vegetation period (Vo Hong et al., 1976, 1977).

The effect of ecological factors on the ratio of organs at different active agent levels

The differentiation according to organs in the alkaloid content of plants is well known (Tétényi, 1970). The part played by this in the total alkaloid production is easy to see, for its quantity can to a great extent depend on what ratio of the dry matter production of the plant falls to the organs richer in active agents and what to those poorer in active agents. In relation to the species examined the quantity of the berries (rich in active agents, 25—30 ‰), and the production ratio of the stem (0—5 ‰), are significant.

On the basis of our investigations, it has been proved that the ecological factors are largely responsible for the development of the organ ratios of the two species examined, nevertheless in *S. dulcamara* characteristics attributable to its perennial life form under the Hungarian climate are also detectable. However, the role of the ecological factors is more general with respect to the active agent level — and in this sense apart from light and temperature, water and nutrient supply is of importance as well.

Influencing the berry ratio — compared with those exceptable in the given developmental stage—can take place relatively, by changing the production ratios of the organs, but it can take place also directly, by triggering off the abscission of berry.

Our results prove that the earlier change in berry ratios of a relative value essentially takes place in the same way in both species (even if to different extents). Triggering off the abscission of berries is on the other hand species-specific and it is essentially determined by the ecological demand and adaptability of the plant examined.

In the modification of the organ ratios (primarily in relation to the berry which decisively influences the total aglycon production), the effect of light, air temperature and water supply proved to be species-specific. This appeared in the triggering off of the abscission of berry in *S. laciniatum* which is less capable of adaptation. It could be stated that in all three factors a critical level (Bernáth 1971; Bernáth and Földesi 1972a) ensued at which in spite of an apparently normal flowering the abscission of shoot, flower and berries developed to no more than 1—7 mm size in (Fig. 6). The multiple causes of triggering off the abscission (including the too high nitrogen supply level:

BERNÁTH and FÖLDESI, 1972b) seem to support the fact abscission is not directly linked to a factor but it is triggered off by the disturbance in the balance of the plants' growth and development occuring under extreme environmental conditions. [It is annother question that for example in Hungary in the case of optimal conditions of cultivation, light and air temperature appear as extreme effects of climatic factors). In the knowledge of the characteristics of berry setting reported by us (BERNÁTH and TÉTÉNYI, 1973), even this unfavourable effect can be reduced. According to our investigations, by an optimal choice of the site of plantation it can be attained that the flowering at the level of the 2nd and 3rd node, which is decisive from the viewpoint of the production of active agent principles, can take place under favourable climatic conditions. In this case it is also attainable that at the time of the cooling and precipitation peaks, which occur in the second half of the breeding period, the set berries have grown beyond the state of sensitiveness of 1—7 mm.

Apart from the extremely unusual conditions, we have never experienced considerable abscission of berries in *S. dulcamara*. Following from its perennial life form it is typical however that the organ ratios of the plants processed after the one-year, two-year and three-year cycles and of those processed continually differ essentially (Fig. 7). In undisturbed vegetation cycles, the

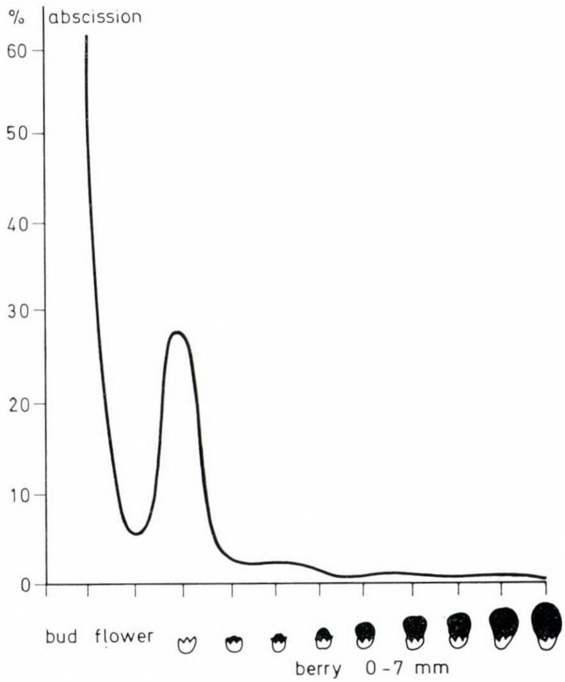

Fig. 6. Changes in abscission of buds, flowers and berries according to the stage of development in *Solanum laciniatum*, during the breeding time

plants in the second and third years primarily develop their stem system which is of no value from the viewpoint of the production of active agent principles. On the other hand, in continual processing (twice a year), the ratio of the organs is unchanged, with nearly a 1/3 ratio of leaf-stem-berry.

The role of nutrient supply is also significant in the change of the organ ratios. We have succeeded in clarifying — beyond the proving in several former publications of the high nutrient demand of identical characteristics, and within this, the nitrogen demand — the characteristics of the changes in organ ratios of both species. This is especially significant with regard to the berry ratio which is decisive with respect to the production of active agent principles. Although the increase in the level of nutrient supply increases the berry

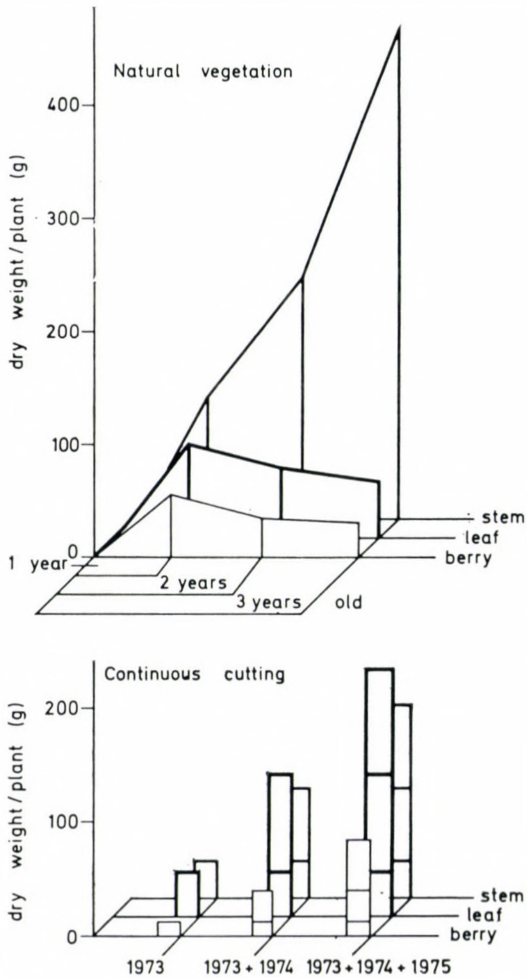

Fig. 7. Changes in the organ ratios of *Solanum dulcamara* plants in three-year vegetation cycles, in undisturbed stands and in such that were cut twice a year

output in both species, the share of the latter in the total weight is lower. Thus, with a relative decrease in the berries of high active agent level must be reckoned with. This change is shown by *S. dulcamara*, according to the data presented in Fig. 8 on the basis of investigations in to four different soil types, in a period of 3 years. From these data it is obvious that the increase of nutrient supply in all soil types is of an identical effect; the stem and leaf fresh weight increases gradually, while the berry weight hardly increases. The supplementary nutrient supply is best utilized in the loose soil type (1)

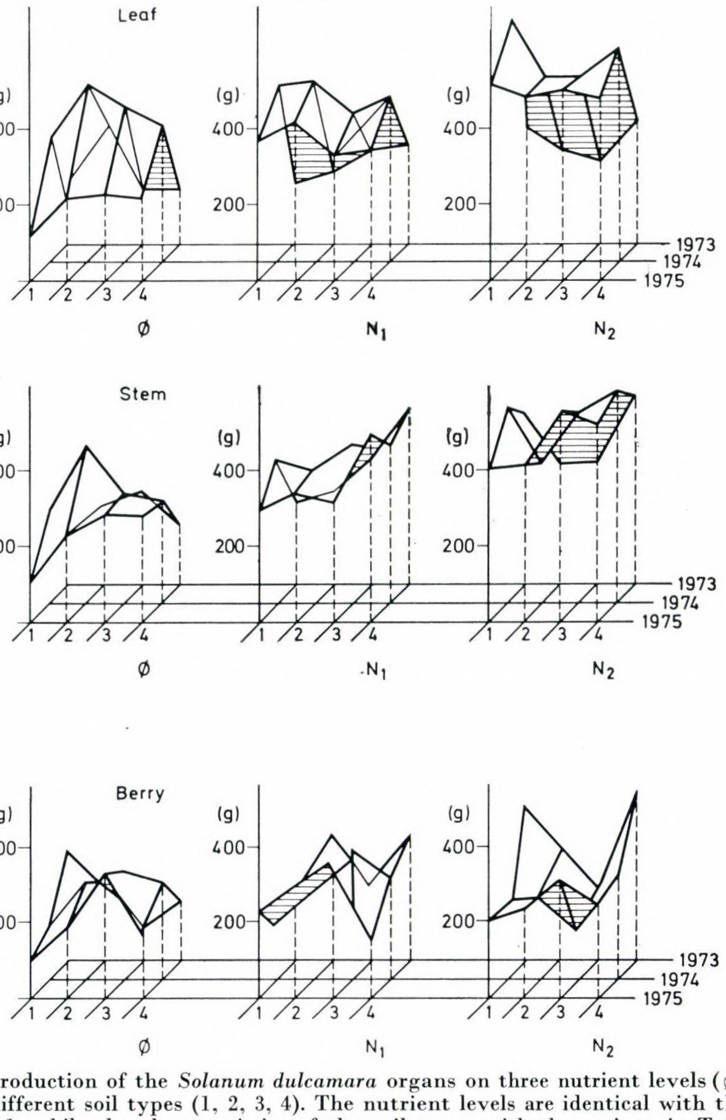

Fig. 8. The production of the *Solanum dulcamara* organs on three nutrient levels (∅, N_1, N_2) and in four different soil types (1, 2, 3, 4). The nutrient levels are identical with those given in Table 1, while the characteristics of the soil types with those given in Table 2

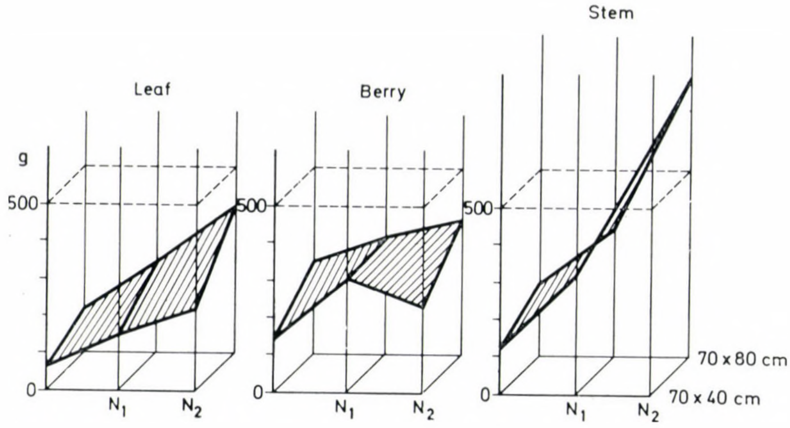

Fig. 9. The production of the *Solanum laciniatum* organs in two culture areas (70 × 40 cm and 70 × 80 cm) and on three nutrient level (Ø, N_1 and N_2). The nutrient levels are identical with the data given in Table 1

which is poor in nutrient. A change of identical character with this is shown by *S. laciniatum* independently of the size of the cultivation area (Fig. 9).

At identical nutrient supply levels applied in *S. dulcamara* dry weight increased nearly logarithmically with the increase in nitrogen quantity, and again leaf weight increased proportionally. On the other hand, the absolute quantity of berry increased only until the level of medium nutrient supply was achieved, it did not change further on, or it decreased. This latter phenomenon is already unambiguously species-specific, and it can be traced back to the abscission of berry in *S. laciniatum*, which is explainable by its increased sensitivity (BERNÁTH and FÖLDESI, 1972b).

The effect of ecological factors on the dry-matter production

On the basis of our investigation, it can be stated that in addition to the favourable organ ratios and the maintenance of the average production of active agent principles in the organs, one of the decisive factors of total alkaloid production is the dry matter production. In spite of the fact that, in determining this, the effect of external ecological factors is complex in nature, the evaluation by factors has become possible experimentally. It has been ascertained that indeed in respect of the dry matter production the effect of ecological factors is the most characteristic and that the effect of all the factors that have been considered is ascertainable.

Light exerts its effect both through its intensity and spectrum composition. Owing to the adaptability of the plant, the effect of intensity is species

specific, while that of spectrum composition is nearly identical in the two maximum species examined (BERNÁTH et al., 1976).

Depending on the optimum of the species examined — the optimum of *S. laciniatum* is the highest — the air temperature either increases or decreases the dry matter production. In relation to *S. laciniatum*, this is nearly in agreement with that active agent level (Fig. 3).

The approximation of the optimum water supply has proved favourable in both species, and the increase in the total dry matter production even reached 100% (BERNÁTH and FÖLDESI, 1972a).

The increase in nutrient supply (Table 1) — primarily through that of the quantity of nitrogen —, in agreement with the data of the literature, increases the dry matter production of both species. Consideration must however be given to the relative and absolute quantitative decrease in the berry ratio. In case of practical purposes, the level of nutrient supply must therefore be chosen in a way that the effect, the decrease in the absolute berry ratio (by berry shedding), should be low, but the descruction in the level of the active agents due to the decrease in the relative ratio, and the excessive aglycon production should be in proportion with each other.

The effect of the soil — according to our experiments carried out in 360 l culture vessels in the field — was of identical character in both species (Table 2). The set soil rich in nutrients proved most favourable, and this, in comparison with the unfavourable conditions, increased the total dry matter production by 30—60%. It should be mentioned that in our investigations the soil type did not influence the organ ratios, and no interrelation between soil type and aglycon level could be detected either. The characteristic aglycon production data of the two species are determined here primarily by the difference in the dry matter production and the difference of nearly an order of magnitude in the aglycon levels of the organs.

Table 1

The effect of nutrient supply on the dry matter production of S. lacinatum and S. dulcamara stand, in a unit of area interpolation on the basis of the average data of the experients carried out in parcels, between 1969 and 1975

Mark	Dose of nutrient Active agent principles kg/ha			*S. laciniatum*		*S. dulcamara*	
				Berry	Total production	Berry	Total production
	N	P_2O_5	K_2O	q/ha		q/ha	
∅	—	—	—	8.53	20.7	3.9	16.0
N_1	181	122	61	15.3	50.8	5.3	22.8
N_2	362	244	122	14.7	64.4	5.1	26.1
			$PD_{5\%}$	3.4	12.3	1.3	7.2

Table 2

The dry matter and aglycon production of S. laciniatum and S. dulcamara related to one plant, according to soil types (on the basis of average data from the experiments carried out in 1969—1975)

Serial number of soil	S. laciniatum		S. dulcamara	
	Dry weight per g	Aglycon production per mg	Dry weight per g	Aglycon production per mg
1.	213.8	3062.8	246.0	436.8
2.	239.8	3341.5	298.0	574.2
3.	240.7	3118.3	305.0	595.8
4.	296.3	3907.4	320.0	624.2
$PD_{5\%}$	45.3	751.0	53.4	112.5

Soil No. 1. Stability No. 28., pH 7.8 Total salt 0.06 N% 0.052, P_2O_5 4.3 mg, K_2O 5.5 mg
Soil No. 2. Stability No. 32., pH 8.1 Total salt 0.13 N% 0.067, P_2O_5 15.7 mg, K_2O 21.5 mg
Soil No. 3. Stability No. 46., pH 7.8 Total salt 0.20 N% 0.176, P_2O_5 50.0 mg, K_2O 42.9 mg
Soil No. 4. Stability No. 42., pH 7.6 Total salt 0.09 N% 0.167, P_2O_5 8.1 mg, K_2O 21.7 mg

Summary

Summarizing our results it can be stated that, even in identical alkaloids, the species examined must be considered, and the changes must be evaluated in a complex manner, by simultaneous by tracing the growth-development and the dry-matter production. This is all the more necessary since, according to the results of our experimental series of nearly ten years, the total alkaloid production of the plants is indeed essentially determined by these factors. The complex character of the effects is indicated in Fig. 10. According to data

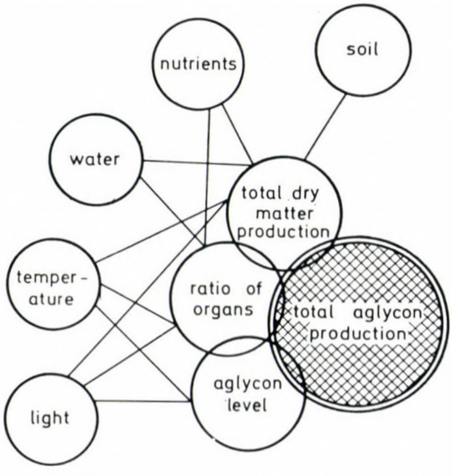

Fig. 10. Factors determining alkaloid production

shown in the Figure it can be stated that it was only in relation to light and air temperature where direct effect on the level of active agent principles of the organs could be detected, although the effect of only the spectrum composition is somewhat more independent of the ecotype. The change of production ratio of the organs of various levels of active agents is on the other hand determined according to ecotype, and in it the importance of water and nutrient supply, in addition to that of light and air temperature, is also verifiable. The rate of total dry-matter production can be influenced the most generally depending on the primary processes. Here, the significance of all the environmental factors can be proved. Accordingly, it is more reasonable to deal with the changes in ecological factor—alkaloid type and in primary reaction—alkaloid production which is dependent on the species — ecotype than with the general, ecological factor — alkaloid production effect.

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CELLULOSE SKELETON STRUCTURE OF THE CELL WALL IN THE GAMETOPHYTON OF *MARCHANTIA POLYMORPHA* L.

II. PARENCHYMA CELLS

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In the thallus of *Marchantia polymorpha* gametophyton, the cellulose skeleton structure of the parenchyma cells, rich in chloroplasts, and of the so-called angular parenchyma cells, were examined. An essential difference was detected between these cell types, with respect to their form and size, or the sub- and light microscopical structure of their cellulose skeleton. It can be inferred that their function is also different, that is physiological differences are reflected in the structural characteristics of their cell wall. In the parenchyma cells, rich in chloroplasts, two different wall structures could be found within the same cell, which means that the walls of these cells becames differenciated correspondingly with their function. With regard to the wall structure, the angular parenchyma cells showed remarkable differences according to their place in the thallus. Both the parenchyma cells rich in chloroplasts and the angular parenchyma cells reached their size characteristic of their fully developed stage within a distance of 3000 micrometers calculated from the growing apex of the thallus. The formation of the incrassation pattern of the angular parenchyma cells could be observed within a 600 micrometer distance from the apex, when the cell reached only 1.3 of its full length. This pattern appeared pronouncedly at a distance of 1300 micrometer from the peak, that is before the full cell size is reached. In both cell types examined, the microfibrils of the individual cell walls were perpendicular to the longitudinal growth direction of the thallus.

Introduction

Parenchyma cells are rather variegated, as regards their morphology and physiology. Their cell wall structural characteristics, manifest mostly in their incrassation, pitted state and optical characters have already been studied by several researchers. It has been established that the birefringence of the elongated parenchyma cell walls is in general negative, which is an indication of transversal microfibrillation. In certain cases, however, a spiral orientation of the microfibrils could be detected (PRESTON, 1938). According to the examinations by WÜHRMANN-MEYER (1935) and FREY-WYSSLING (1942), the originally transversal microfibrillation of the parenchyma cells switches to an axial direction during the longitudinal growth. WARDROP and CRONSHAW (1958) described a crossed microfibril arrangement in the developed cell wall

of *Avena* coleoptyl. By means of the polarization microscope, MÜHLETHALER (1950) observed a rib-like thickening of identical direction that of the edges of the cell, also in the *Avena* coleoptyl parenchyma cell walls. By means of the electron microscope, he established that the microfibrils running in the incrassations are parallel to the edges of the rib and the cell. FRIVALDSZKY—NAGY (1966) described the wall structural characteristics of parenchyma cells with special development. The submicroscopical structure of parenchyma cells occurring in stems and roots was thoroughly examined, using the polarization microscope, by CZAJA (1958, 1961).

In our earlier study (DÖMÖTÖR-SZILÁGYI and WOJNÁROVITS-HRAPKA, 1977), the abaxial epidermis cells of *Marchantia polymorpha* gametophyton and its smooth and tubercled rhizoids were discussed. Concerning the cellulose skeleton structure of the cell wall, our results confirmed the findings according to which the structure of the various walls may be different even in the case of one single cell, depending on whether they are adjacent to a similar cell type, or to another cell type, or to the external environment (FRIDVALSZKY and NAGY, 1966; FRIDVALSZKY, 1967; SMITH, 1972).

The parenchyma cell walls of *Marchantia polymorpha* gametophyton were studied by DIPPEL (1968), using the polarization microscope. Since the submicroscopic structure of the cell wall, has become familiar by means of the electron microscope and scanning electron microscope, the cellulose skeleton structure of the parenchyma cell walls of *Marchantia polymorpha* gametophyton and their growth characteristics have not yet been examined. The aim of our investigations was to meet this need. In this regard, further detailed investigations seemed to be necessary, especially in connexion with the growth processes, and recent methods or instruments of examinations, such as the scanning electron microscope.

Material and method

In our earlier study, the experimental methods were described in detail (DÖMÖTÖR-SZILÁGYI and WOJNÁROVITS-HRAPKA 1977). Therefore, here they will be mentioned briefly. The *Marchantia polymorpha* L. gametophytons were obtained from the greenhouse of the Botany Garden of the Eötvös Loránd University, Budapest. For the polarization microscopical investigations cross sections and longitudinal sections were prepared from the thalluses, from which the plasma and matrix materials were removed (SCOTT et al., 1956). Part of the sections were kept unstained, other parts were stained with chlorine-zinc-iodine or Congo red. The covering of the preparations was made by means of watered glycerine. The examinations were carried out by means of a Jena ZEISS-manufactured polarization microscope. For the qualitative observations, first rate red sheet were inserted. For the scanning electron microscopic examinations, similarly to the method described earlier (DÖMÖTÖR-SZILÁGYI and WOJNÁROVITS-HRAPKA 1977), fixed and purified pieces of the thallus were used, which underwent vacuum evaporation in a 2.10^{-5} hgmm vacuum and were given a golden coat of about 200 Å thickness. The scanning electron microscopic examinations were made by means of a JSM—U—JEOL type scanning electron microscope.

When examining the rate of growth of the cells, the distances were measured by means of a micrometer eyepiece. The data refer to the averages of 20 measurements in each cases.

Results and their assesment

The cellulose cell wall structure of fully developed parenchyma cells rich in chloroplasts, occurring at about 22 mm from the growing apex of the thallus

Below the adaxial epidermis, large, broad, intercellular cavities containing air, the so-called assimilation chambers lie horizontally, side by side to each other, which are separated by columnar tissue blands vertical to the surface. From below the large assimilation chambers, short cell filaments elongated into the cavity. Their cells contain a great number of chloroplasts, which are well recognizable in cross section, longitudinally and also from a superior view (Fig. 1). The form of the parenchyma cells constituing the filaments, and containing chloroplasts, is approximately isodiametric, their diameter is 14 micrometer. The walls of the cells from which the plasma content has been removed, were — although slightly, but definitely — birefringent in the polarization microscope. By inserting the Red I plate even the character of birefringence could be established. In this respect, a difference occurred between the side walls (those on the side of the assimilation chamber) and the transversal walls of cells (those separating the cells of cell filaments). In the side walls the refractive index parallel to the height of the wall was the biggest, from which i' can be inferred that the microfibrils of these cell walls arranged in the same

Fig. 1. Superior view of the relatively young parenchyma cell layer, rich in chloroplasts of the *Marchantia polymorpha* L. gametophyton, between crossed nicols (×20 obj. ×4 oc.)

direction and so they are perpendicular to the frontal plane of the thallus. By similar examination of the transversal walls (basal and covering sheets) it was established that their microfibrils were perpendicular to the main growth direction of the thallus. In Fig. 2, the data obtained with regard to the cellulose skeleton structure of the parenchyma cells rich in chloroplasts are summarized.

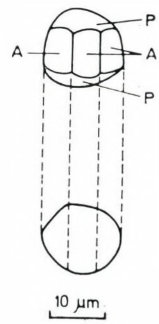

Fig. 2. Stereoscopic sketch of the cellulose skeleton structure of the lateral parenchyma cell rich in chloroplasts of the *Marchantia polymorpha* gametophyton. A = anticlinal cell walls, P = periclinal cell walls

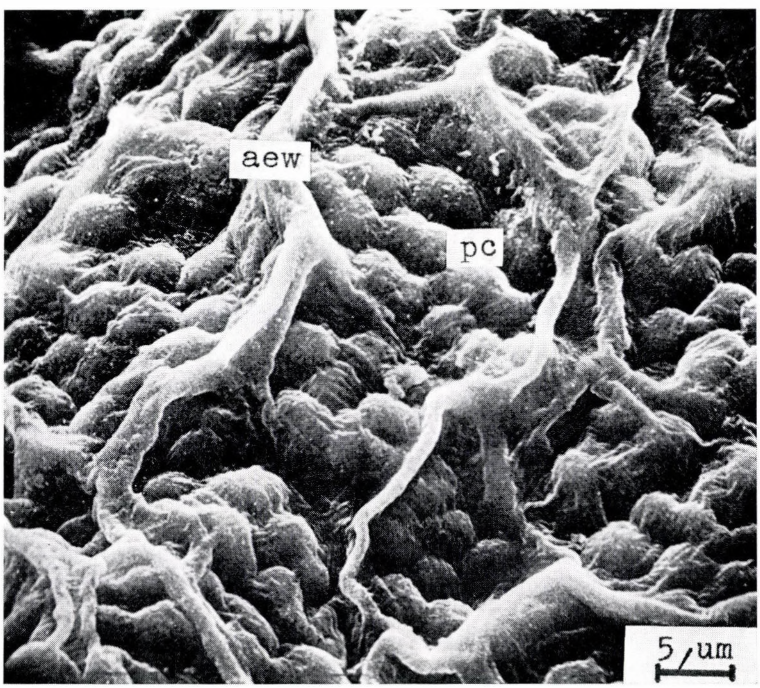

Fig. 3. Superior view of *Marchantia polymorpha* gametophyton. Scanning electron microscopic picture, ×2000; aew = periclinal cell wall of adaxial epidemis cells, pc = parenchyma cells, rich in chloroplasts (lapping over by the periclinal cell walls of the adaxial epidermis cells)

Growth of the cellulose skeleton structure of the parenchyma cell rich in chloroplasts

Their shape, strongly approximating a globular form, is well distinguishable at their young stage by the scanning microscope, through the basal and covering sheet of the adaxial epidermis cells lapping over the the parenchyma cells (Fig. 3). Since these cells are isodiametric even at their young stage, their growth rate is unidirectional, which is illustrated in Fig. 4. At a distance of 150 micrometers from the apex, their diameter is 6 micrometers. They reach the final size, which is 14 micrometers on the average, at a distance between 2400—3000 micrometers from the apex. Thus, their growth in the given section is more than double in every direction. In their cell walls, which are extremely thin even in their fully developed stage, there were no pattern when observed by polarization or by scanning electron microscope (Figs 5 and 6). The microfibril orientation which could be detected in their young cell walls was identical with that established in the mature stage (Fig. 7).

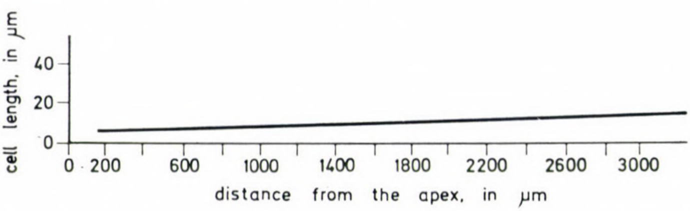

Fig. 4. Graph of the growth of parenchyma cells rich in chloroplasts

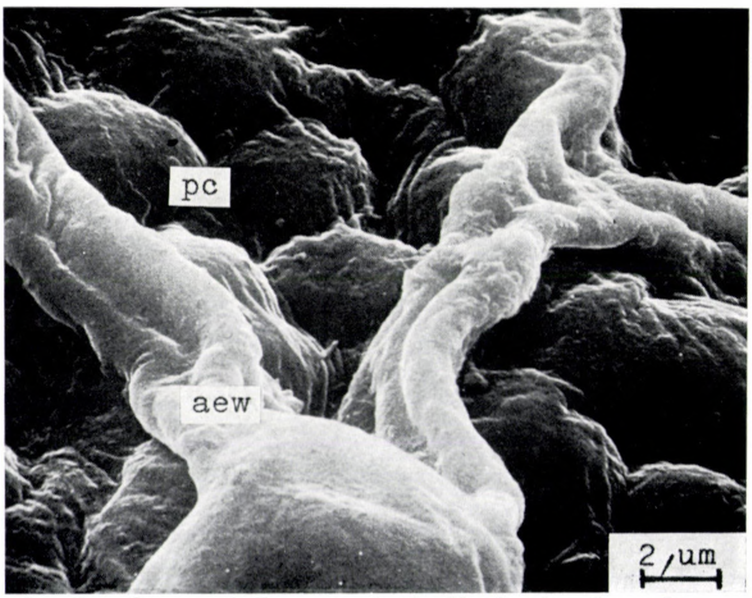

Fig. 5. Superior view of young thallus region in the *Marchantia polymorpha* gametophyton. Scanning electron microscopical picture, ×5000 aew = periclinal cell wall of adaxial epidermis cells, pc = parenchyma cell, rich in chloroplasts (lapping over by the periclinal cell wall of the adaxial epidermis cell)

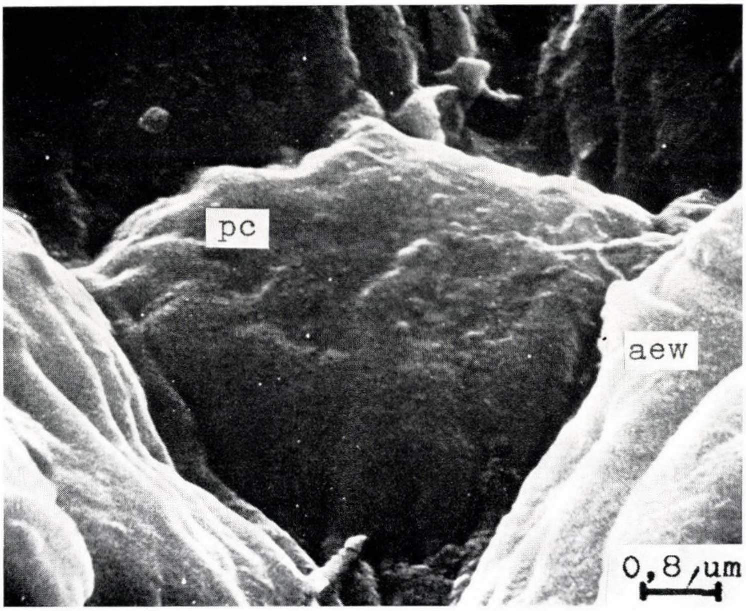

Fig. 6. Superior view of the young thallus region of the *Marchantia polymorpha* gametophyton. Scanning electron microscopical picture. ×12,000; aew = periclinal cell wall of adaxial epidermis cells, pc = parenchyma cell, rich in chloroplasts (lapping over by the periclinal cell wall of the adaxial epidermis cell)

The cellulose skeleton structure of the fully developed angular parenchyma cells occurring at a distance of about 22 mm from the growing apex of the thallus

Below the assimilating cell fibrils rich in chloroplasts, near the lateral edges, approaching the rib, there can be seen a layer consisting of increasingly larger cells in more and more cell rows (Fig. 8). These cells cross sectionally and longitudinally as well as from a superior view are of hexagonal shape, and are the greatest in the near-rib region of the lateral part. According to the measurements carried out here, their greatest extension corresponds to the growth direction of the thallus, 120 micrometer on the average. In the processed preparations, their position is well observable and it is seen that they are slightly elongated in the growth direction of the thallus. The average of their width measured transversally towards the thallus is 85 micrometer. On the basis of the cross sectional and longitudinal preparations, it can be stated, that their smallest extent is perpendicular to the frontal plane of the thallus. The average of the shorter cell wall height measured in this direction is 20 micrometer, and again that of the greatest cell height is 43 micrometer.

In those walls of the large angular parenchyma cells, lying in the near-rib region of the lateral part, through which the cells mentioned communicate with each other, there are rib-like thickenings running parallel to the cell height

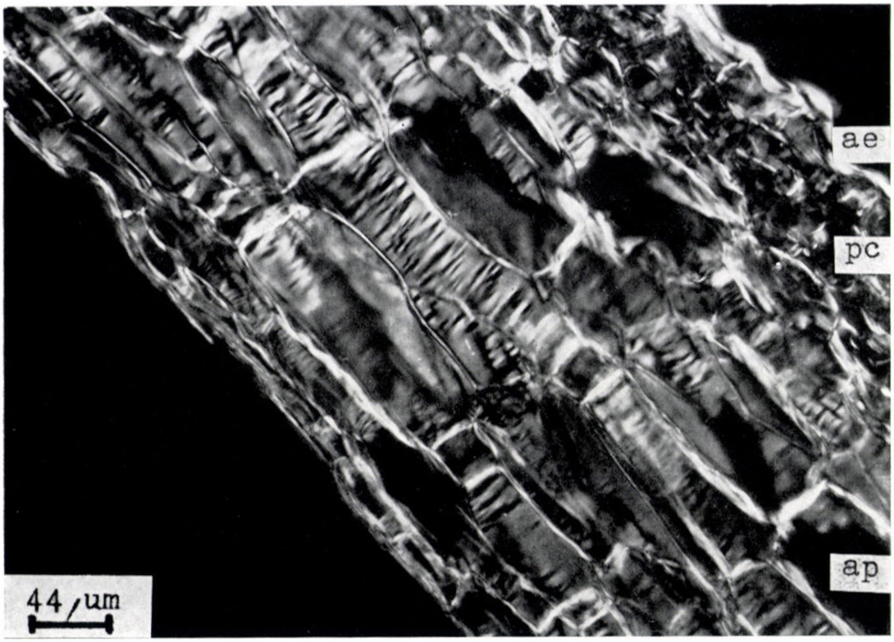

Fig. 8. Longitudinal section of the rib-edge area of fully developed thallus region in *Marchantia polymorpha* gametophyton, between crossed nicols (×20 obj., ×3.2 oc.). ae = adaxial epidermis; pc = parenchyma cells rich in chloroplasts; ap = angular parenchyma cells

or to each other. As a result of their strong birefringence these ribs are especially conspicious in the polarization microscope. They separated from each other at proportionate distances, at the full height of the cell wall. Whithin these distances, further partial separations can be observed; consequently, they remind us of pillars lying or against several stands. Their higher magnification also shows that these pillars are not of a solid structure, but may be composed of fine fibres which occassionally bridge over the interlying thinner cell wall parts (Fig. 9 arrow).

Towards the middle part of the thallus, the rib-like incrassations in the cell walls, lying in the longitudinal plane of the angular parenchyma cells become wider, since the smaller units (pillars) which separate in their whole length, become increasingly more dense (Fig. 10) and again, the number of pillars occasionally decreases in a way that they appear on only one third of the cell walls; on the other 2/3 of the cell wall only thinner cell wall parts of a very reduced size can be seen (Fig. 11). Their shape also changes. They are increasingly more elongated towards the mid part of the thallus. It must be emphasized that in the lateral walls of the parenchyma cells lying in either part of the thallus — as could be stated by means of the Red I plate, between the crossed nicols — the orientation of the microfibrils is in agreement with the direction of the thickenings (Figs 10 and 12).

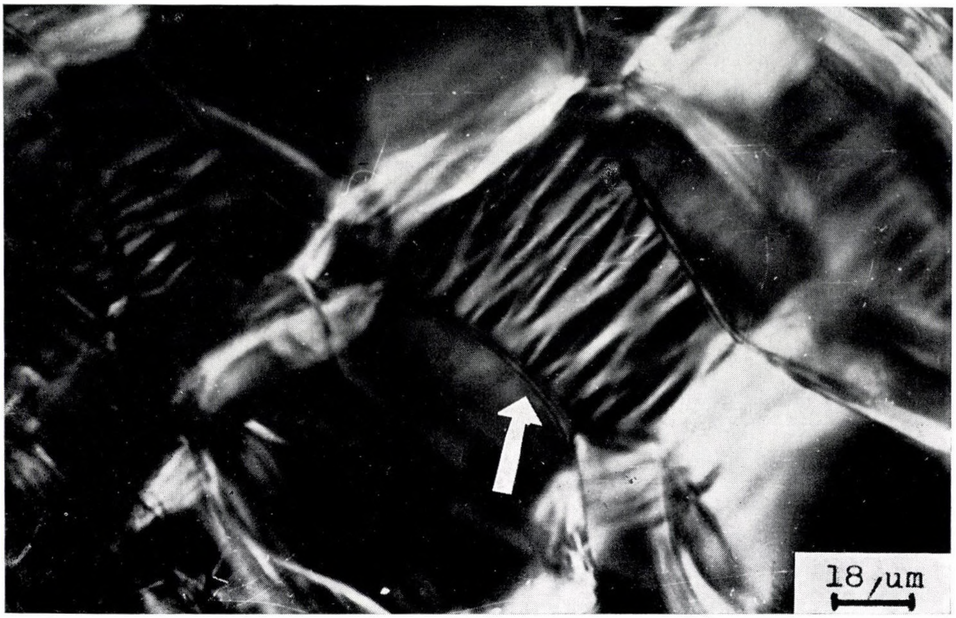

Fig. 9. Cross section of the lateral, near-rib, growing thallus region of *Marchantia polymorpha* between crossed nicols (×20 obj., ×8 oc.)

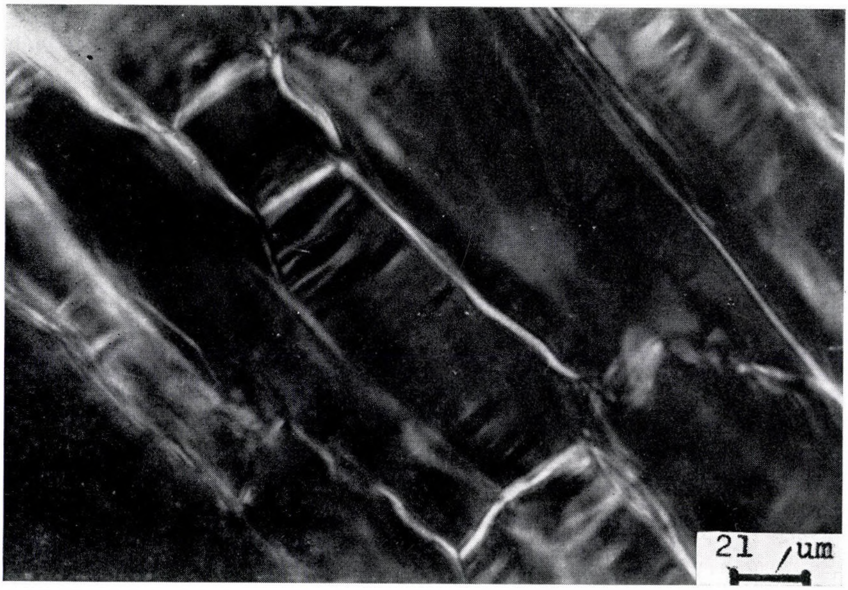

Fig. 11. Longitudinal section of the fully developed thallus part of *Marchantia polymorpha*. Centre: the anticlinal cell wall of an elongated angular parenchyma cell, near the rib edge and near the abaxial epidermis; ×20 obj., ×8 oc.

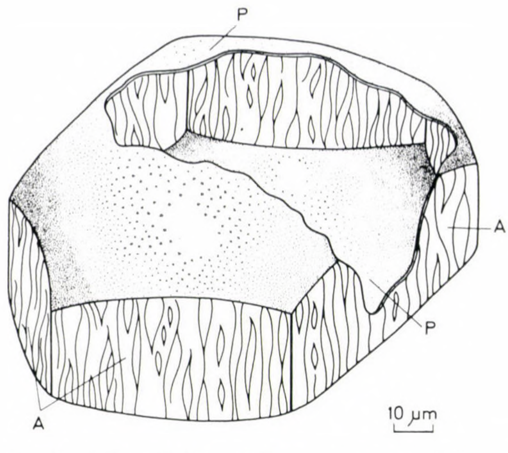

Fig. 13. Stereoscopic sketch of the cellulose skeleton structure of the angular parenchyma cell, which lying in the lateral part of the thallus and near the rib of the *Marchantia polymorpha*. A = anticlinal cell walls, P = periclinal cell walls

In cross sectional preparations, the walls constituting the covering and basal sheets of the parenchyma cells can be seen. Their covering and basal sheets foımed by the adaxial epidermis and the adjacent cell of identical type, between crossed nicols, manifest themselves as slightly and uniformly birefringent. In these cell walls, the greatest refractive index is perpendicular to the growth direction of the thallus. From this it follows that the direction of the microfibrils is also of a transversal with respect to the growth direction of the thallus. The wall structural characteristics of the angular parenchyma cell of lateral near-rib position are summarized in Fig. 13, and again those of the rib region parenchyma in Fig. 14.

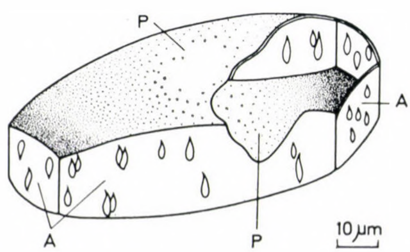

Fig. 14. Stereoscopic sketch of the cellulose skeleton structure of the angular parenchyma cell, lying in the rib of *Marchantia polymorpha* gametophyton. A = anticlinal cell walls, P = = periclinal cell walls

The growth of the cellulose skeleton structure of the angular parenchyma cells (in lateral, near-rib position)

The longitudinal axis of the angular parenchyma cells is of 18 micrometer, at a distance of 150 micrometers from the apex. The length of 120 micrometers, which is characteristic of the mature stage, is reached at a distance

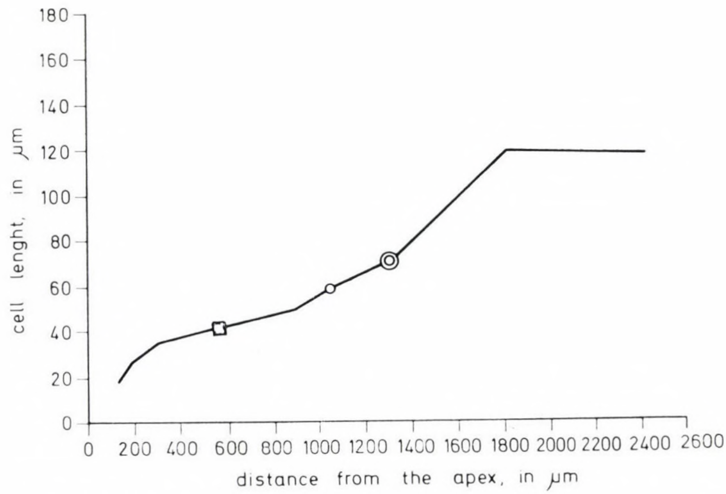

Fig. 15. Graphical illustration of the connexion between the longitudinal growth and skeleton structure differentiation of the angular parenchyma cells lying laterally, near the rib

□ = appearance of the rib-like incrassations of the anticlinal cell walls
○ = a more pronounced presence of the rib-like incrassations of the anticlinal cell walls
◎ = a very pronounced presence of the rib-like incrassations

of 1800 micrometers from the growth apex of the thallus. Thus, in the meantime, it undergoes a six and a half times' elongation. The width of the cell in an identical section increased from 15 micrometers to 80 micrometers that is to its 5.3 times size. The height of the cell increased altogether to a three times higher value, from 14 to 43 micrometers. Under the polarization microscope, at a distance of 570 micrometers from the apex of the thallus signs of initial incrassation and microfibril orientation characteristic of the longitudinal cell walls could be detected. At a distance of 1050 micrometers from the apex this wall structure is even more pronounced, while later is more defined. The growth rate of the lateral, angular parenchyma cell is illustrated graphically (Fig. 15).

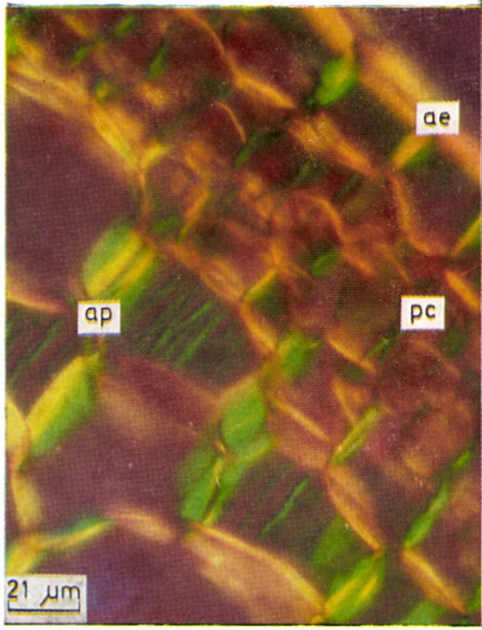

Fig. 7. Cross-sectional picture of the young *Marchantia polymorpha* gametophyton between crossed nicols, by inserting Red I plate. (20 × obj., 8 × oc.). ae = adaxial epidermis; pc = parenchyma cells rich in chloroplasts; ap = angular parenchyma cells rich in chloroplasts; ap = angular parenchyma cells

Fig. 10. Longitudinal section of the fully developed thallus of *Marchantia polymorpha* gametophyton. Centre: the anticlinal cell wall of the elongated angular parenchyma cell in the ribedge region, between crossed nicols; by inserting Red I, plate; ×20 obj., ×8 oc.

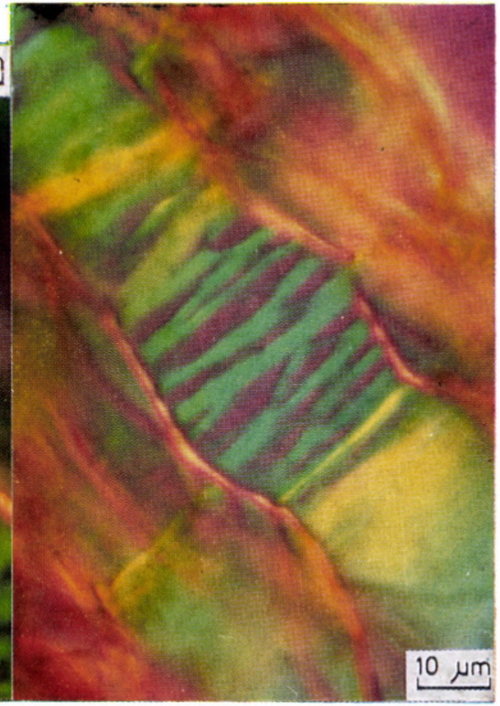

Fig. 12. Longitudinal section of the fully developed thallus part of *Marchantia polymorpha*. Centre: anticlinal cell wall of an angular parenchyma cell, which lying in the lateral part of the thallus and near the rib, between crossed nicols, by inserting Red I. plate; ×40 obj., ×8 oc.

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THE SPOROMORPHAE OF AN ANGOLAN BROWN COAL

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In the course of a palynological processing of coal specimens originating from the valley of Lungue Bungo river in Angola, the authors found 36 fossil spore-pollen taxa. *Megaporoites angolaensis* n. fsp., *Graminidites magnianulatus* n. fsp. and *Cyperaceaepollis angolaensis* n. fsp. and *Cyperaceaepollis africanus* n. fsp. have been described as new taxa. In the course of describing the sporomorphae, the authors also carried out the SEM examinations of two fsp.

On the basis of the sporomorphae, the identification of 22 recent taxa has been carried out; of these, 14 were determined up to family, 2 to subfamily, 3 to genus, and 3 to species.

The coal-forming swamp was *Cyperus papyrus*. This swamp received pollen material from a grassland with numerous *Compositae*, from a gallery forest and from a dwarf plant swamp in rock depression, and from a farther lying *Podocarpus* forest.

At the time of the development of the coal-forming swamp, the area could be more moisterous. The authors put the time of its formation at the Upper Tertiary-Quaternary period or at the Lower Quaternary.

I. Introduction

In an earlier publication (KEDVES and SIMONCSICS 1968), we reported on the spore pollen examination of the brown coal deposit occurring along the river Lungue Bungo in Angola; on the basis of a large-scale analysis we stated that

(1) in the material, *Pteridophyta* and *Gymnospermatophyta* are few in number; from the *Angiospermatophyta*, *Cyperaceae* and *Gramineae* are dominant; *Palmae* are again few in number; types indicating *Compositae* and *Umbelliferae* (*Apiaceae*) occur only sporadically; there occur *Myricaceae; Hippocrateaceae* and *Droseraceae* occur occasionally;

(2) on the basis of the spore-pollen types, the age of coal formation could be the Upper Tertiary or the Quaternary further

(3) the climatic factors of the area could not be significantly different from those of today, and finally

(4) the coal deposit could partly be formed by the silting up of the one-time sediment-catcher; the sinking of the relief—which kept level with the production of plant materials, a basis of coal—and the accompanying continual water supply must also have played a role in the formation of the layer.

In our present paper, we endeavour to determine — at the present stage of our knowledge — the sporomorphae found in the brown coal, and the recent taxa represented by them.

II. The sporomorphae of brown coal

1. Camarozonosporites (Hamulatisporis) rarus (Doktorowicz—Hrebnicka 1960) W. Kr. 1963 (Pl. I, 1—4).

Botanical connection: Lycopodiaceae.

Occurrence: From the Miocene to the Pleistocene, mainly in European deposits.

2. Laevigatosporites haardti (R. Pot. & Ven. 1934) Th. & Pf. 1953 subfsp. **haardti** (Pl. I, 5, 6).

Botanical connection: Polypodiaceae.

Occurrence: Beginning mainly from the Lower Tertiary, but it also occurs in recent deposits, as a *Polypodiaceae* spore free from perisporium.

3. Podocarpidites (Cookson 1947) Couper 1953 **sp.** (Pl. I, 7—10). It was represented only by a new specimens. This type is different from the more known forms of fossile *Podocarpidites.* A certain similarity to *Podocarpidites ellipticus* Cookson 1947, to *Podocarpidites sp.* 1 described by Sah (1967) and Sah and Kar (1969) can be detected. We have found several literary data on that the pollen grain stated by us is of a *Podocarpidites,* gracilior type. The pollen of the recent species was described by Bonnefille (1971), from Ethiopian montane forests. Rossignol (1961) described this type from Israelian recent deposits; Bonnefille (1969) from also recent Ethiopian deposits, too. Although the type is not indicated more closely, but the same type is dealt with in the work of Saad and Sami (1967) on the recent deposits from the delta of the Nile.

Plate I

1, 2: Camarozonosporites (*Hamulatisporis*) *rarus* (Doktorowicz—Hrebnicka 1960) W. Kr. 1963, *Lycopodiaceae,* prep. Angola III; 8. 8/122. 1.

3, 4: Camarozonosporites (*Hamulatisporis*) *rarus* (Doktorowicz—Hrebnicka 1960) W. Kr. 1963, *Lycopodiaceae,* prep. Angola V; 9. 1/118. 9.

5, 6: Laevigatosporites haardti (R. Pot. & Ven. 1934) Th. & Pf. 1953 subfsp. *haardti, Polypodiaceae,* prep. Angola XX; 11. 9/113. 1.

7, 8: Podocarpidites fsp., *Podocarpaceae,* prep. Angola V; 13. 4/101. 6.

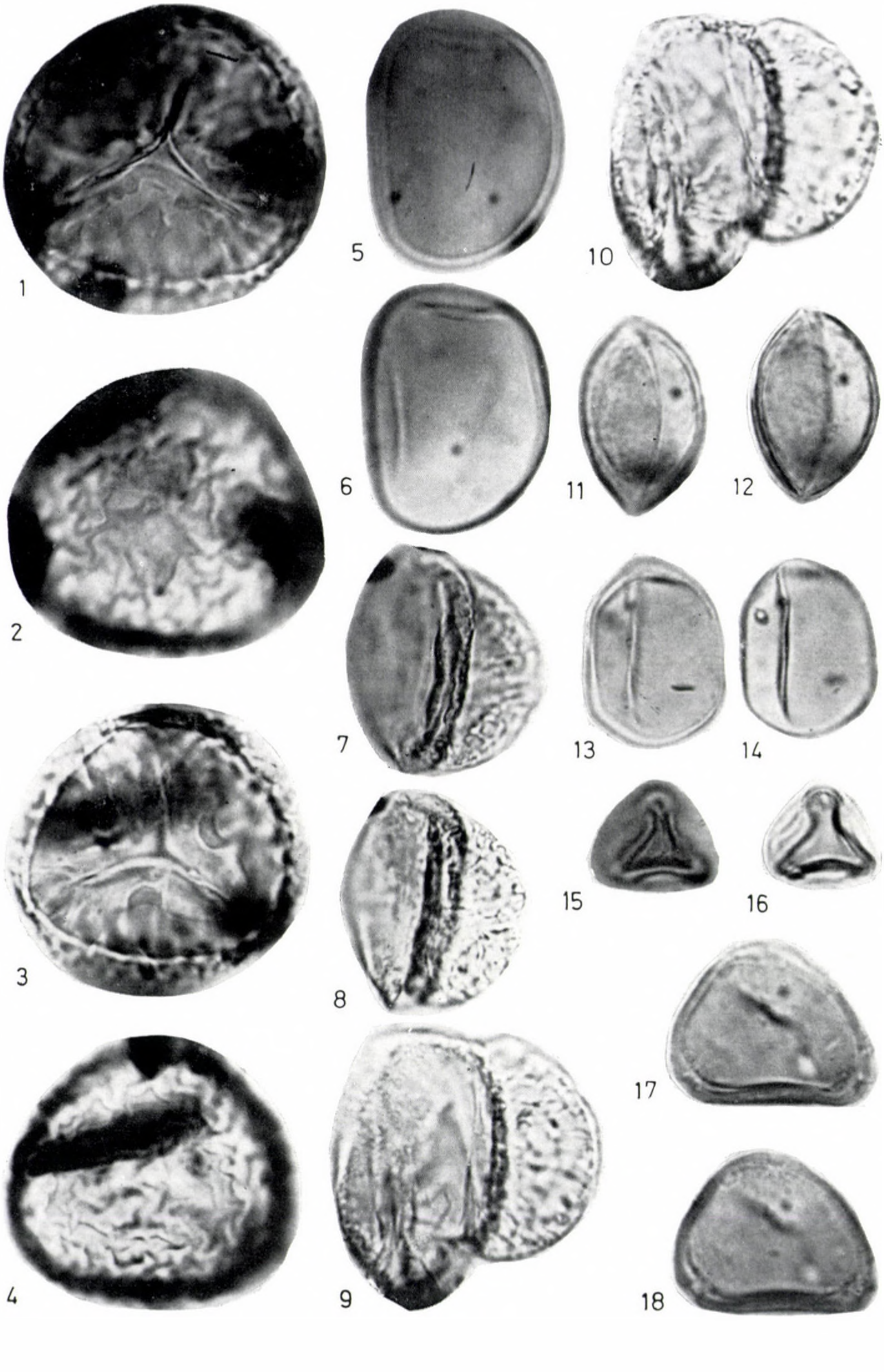
9, 10: Podocarpidites sp., *Podocarpaceae,* prep. Angola IV; 18. 7/124.

11, 12: Cycadopites cf. *minor* (Kds. 1961) Kds. 1968, *Cycadaceae* v. *Spadiciflorae,* prep. Angola IV 6. 9/107. 7.

13, 14: Monocolpopollenites cf. *tranquillus* (R. Pot. 1934) Th. & Pf. 1953 subfsp. *tranquillus, Palmae,* prep. Angola XVII; 13.4/107.8.

15, 16: Trivestibulopollenites sp., prep. Angola XX; 20.4/119.8.

17, 18: Triporopollenites sp., cf. *Myricaceae,* prep. Angola XVII; 7.1/120.0 ×1000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4. Cycadopites cf. minor (Kds. 1961) Kds. 1968, *Cycadales* v. *Spadiciflorae* (Pl. I, 11, 12). This pollen type has been described from Eocene layers. The producing plant of the Angolan pollen is probably not identical with that of the older Tertiary forms. Its connection with *Cycadales* (*Stangeria, Encephalartos, Cycas*) is however presumable.

5. Monocolpopollenites cf. **tranquillus** (R. Pot. 1934). Th. & Pf. 1953 subfsp. **tranquillus** (Pl. I, 13, 14).

It is a very frequent forms in European deposits, first of all from the lower Tertiary. Various palm genera can be taken into consideration as botanical relation.

6. Trivestibulopollenites sp. (Pl. I, 15, 16). Besides the vestibulum, its plicate character is remarkable. In European deposits, *Trivestibulopollenites* mainly indicates *Betulaceae*. We were able to observe it only in one specimen.

7. Triporopollenites sp. (Pl. I, 17, 18).

It is to a certain extent similar to *Triporatus kashmirensis* described by THIERGART and FRANTZ (1961) the botanical relation of which was given as *Betulaceae*. We consider its origination from *Myricaceae* more probable.

Fgen.: **Megaporoites** W. Kr. 1970

8. Megaporoites angolaensis n. fsp. (Pl. II, 1—4).

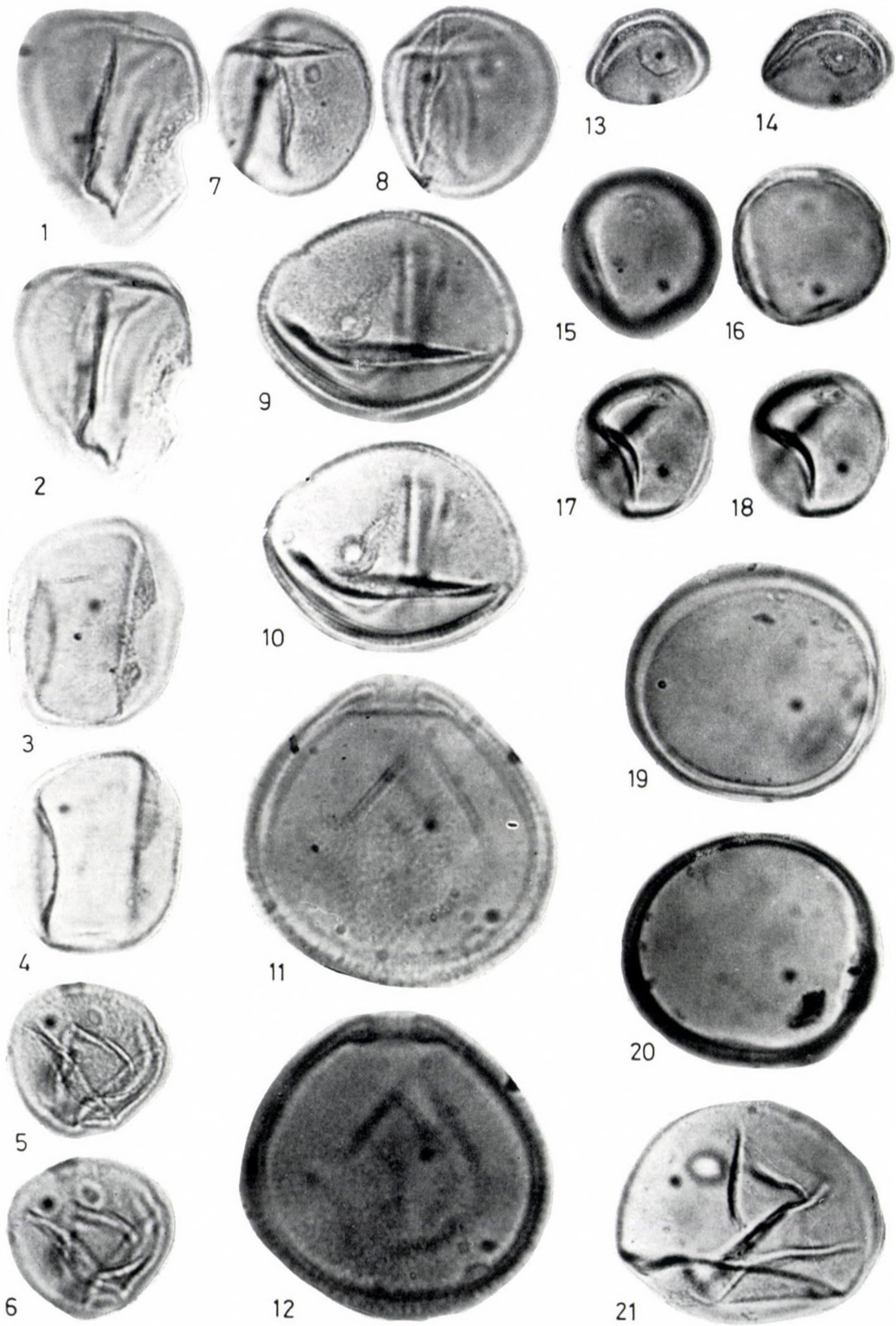
Diagnosis: Originally globular, secondairly plicated pollen grain. We did not light microscopically succed in observing pronounced ornamental elements on the surface; it seem scabrous. The exine is of a 0.5—0.8 μm thickness, separates into three layers; these are of about the same thickness. The elements of the infratectal layer are columniform. The pore originally circular its diameter is around 10 μm, no annulus or other kind of differentiatedness can be observed on its margin, but the sexine around it is more scabrously ornamented.

Maximum size: 28—35 μm.

Holotype: Pl. II, 1, 2, prep. Angola XVIII; 5.4/105.8.

Plate II

1, 2: *Megaporoites angolaensis* n. fsp., *Restionaceae* v. *Centrolepidaceae*, prep. Angola XVIII; 7.4/118.4.
3, 4: *Megaporoites angolaensis* n. fsp., *Restionaceae* v. *Centrolepidaceae*, prep. Angola XVIII; 5.4/104.8.
5, 6: *Graminidites laevigatus* W. Kr. 1970, *Gramineae*, prep. Angola VIII; 7.3/103.9.
7, 8: *Graminidites laevigatus* W. Kr. 1970, *Gramineae*, prep. Angola X; 17.3/113.2.
9, 10: *Graminidites* cf. *pseudogramineus* W. Kr. 1970, *Gramineae*, prep. Angola III; 12.3/12.38.
11, 12: *Graminidites* cf. *assamicus* Sah and Dutta 1967, *Gramineae* v. *Restionaceae*, prep. Angola XVII 18.5/103.2.
13, 14: *Graminidites magnianulatus* n. fsp., *Gramineae*, prep. Angola III; 18.2/114.8.
15, 16: *Graminidites* cf. *neogenicus* W. Kr. 1970, *Gramineae*, prep. Angola XVI; 16.8/102.8.
17, 18: *Graminidites* cf. *neogenicus* W. Kr. 1970, *Gramineae*, prep. Angola III; 20.5/114.8.
19, 20: *Graminidites soellichauensis* W. Kr. 1970, *Gramineae*, prep. Angola XVI; 17.9/114.2.
21: *Graminidites pseudogramineus* W. Kr. 1970, *Gramineae*, prep. Angola II; 20.6/119.8; ×1000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Locus typicus: Upper Piiocene exploration by the side of the river Lungue Bungo, Angola.

Stratum typicum: Brown coal.

Derivatio nominis: after Angola.

Differential diagnosis: It is differentiated from *M. saxonicus* W. Kr. 1970 by its three-layered exine and by the considerably smallei structure elements of the exine.

Botanical relation: Restionaceae can mainly be considered, but *Centrolepidaceae* is morphologically not excluded either. Since the latter family occurs in Australia, New Zealand and New Guinea today, it can be left out of consideration.

Occurrence: For the time being it is known lony from the locus typicus.

Gen.: **Graminidites** Cookson 1947

The pollen grains belonging in here are monoporate, their surface is scabrous light-microscopically; the annulus around the pore is characteristic. Their botanical relation is primarily *Gramineae*, but the tropical *Restionaceae*, especially here, can also be taken into consideration.

9. Graminidites laevigatus W. Kr. 1970 (Pl. II, 5—8), *Gramineae.*

10. Graminidites cf. **pseudogramineus** W. Kr. 1970 (Pl. II. 21) *Gramineae.*

11. Graminidites cf. **assamicus** Sah & Dutta 1967 (Pl. II, 11, 12). This can also be *Restionaceae.*

12. Graminidites magnianulatus n. fsp. (Pl. II, 13, 14).

Diagnosis: Originally globose pollen grains. By the light microscope, the surface is finely scabrous. The exine thickness around 0.5 μm; very thin; its separation into layers is difficult to observe. The elements of the infratectal layer are not pronounced; an intrabaculate structure is not recognizable. The pore is small, its diameter is always below 1 μm (0.5—0.7 μm). The annulus is pronounced, its diameter is 2—3 μm, its margin is sometimes wavy.

Maximum size: 15—20 μm.

Plate III

1: Graminidites pseudogramineus W. Kr. 1970, *Gramineae*, prep. Angola II; 20.6/119.8.
2, 3: Graminidites soellichauensis W. Kr. 1970, *Gramineae*, prep. Angola VI; 18.1/113.2.
4, 5: Graminidites congoensis Sah 1967, *Gramineae*, prep. Angola XIX; 13.4/119.6.
6, 7: Cyperaceaepollis angolaensis n. fsp., *Cyperaceae, Cyperus*, prep. Angola III; 14.7/105.8.
8, 9: Cyperaceaepollis angolaensis n. fsp., *Cyperaceae, Cyperus*, prep. Angola XVI; 17.8/104.7.
10, 11: Cyperaceaepollis angolaensis n. fsp., *Cyperaceae, Cyperus*, prep. Angola XVIII; 20.3/106.
12, 13: Cyperaceaepollis angolaensis n. fsp., *Cyperaceae, Cyperus*, prep. Angola XVIII; 9.0/118.6.
14, 15: Cyperaceaepollis africanus n. fsp., *Cyperaceae*, cf. *Ascolepis*, prep. Angola XVIII; 14.9/115.9.
16, 17: Cyperaceaepollis africanus n. fsp., *Cyperaceae*, cf. *Ascolepis*, prep. Angola XX; 13.4/102.8.
18, 19: Cyperaceaepollis africanus n. fsp., *Cyperaceae*, cf. *Ascolepis*, prep. Angola XVI; 20.6/118.8; ×1000


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Holotype: Pl. II, 13, 14, prep. Angola III; 18.2/114.8.

Locus typicus: Angola, excavation along the river Lungue Bungo, Angola; Upper Pliocene.

Stratum typicum: Brown coal.

Derivatio nominis: After its annulus being large in relation to the pollen grain size.

Differential diagnosis: Its smaller size and relatively wide annulus well differentiate it from *G. gracilis* W. Kr. 1970.

Occurrence: For the time being known only from the locus typicus.

Botanical relation: Gramineae.

13. Graminidites cf. **neogenicus** W. Kr. 1970 (Pl. II, 15—18).

14. Graminidites soellichauensis W. Kr. 1970 (Pl. II, 19, 20; Pl. III, 2, 3; Pl. IV, 1—3).

In this form-species, we carried out scanning electron microscopic examinations too; they have made our knowledge of surface more accurate. The surface is ornamented with tiny coni, which may have a role in receiving pollen in impregnation, as in an anemophil species. Several literary data are available on the scanning electron microscopical examination into the pollen grains of recent *Gramineae* species. For example, the work of GRANT (1972) and ANDERSEN and BERTELSEN (1972) can be mentioned. On the basis of these, the surface ornamentation may well be of taxonomical values.

15. Graminidites congoensis Sah 1967 (Pl. III, 4, 5).

Gen.: **Cyperaceaepollis** W. Kr. 1970

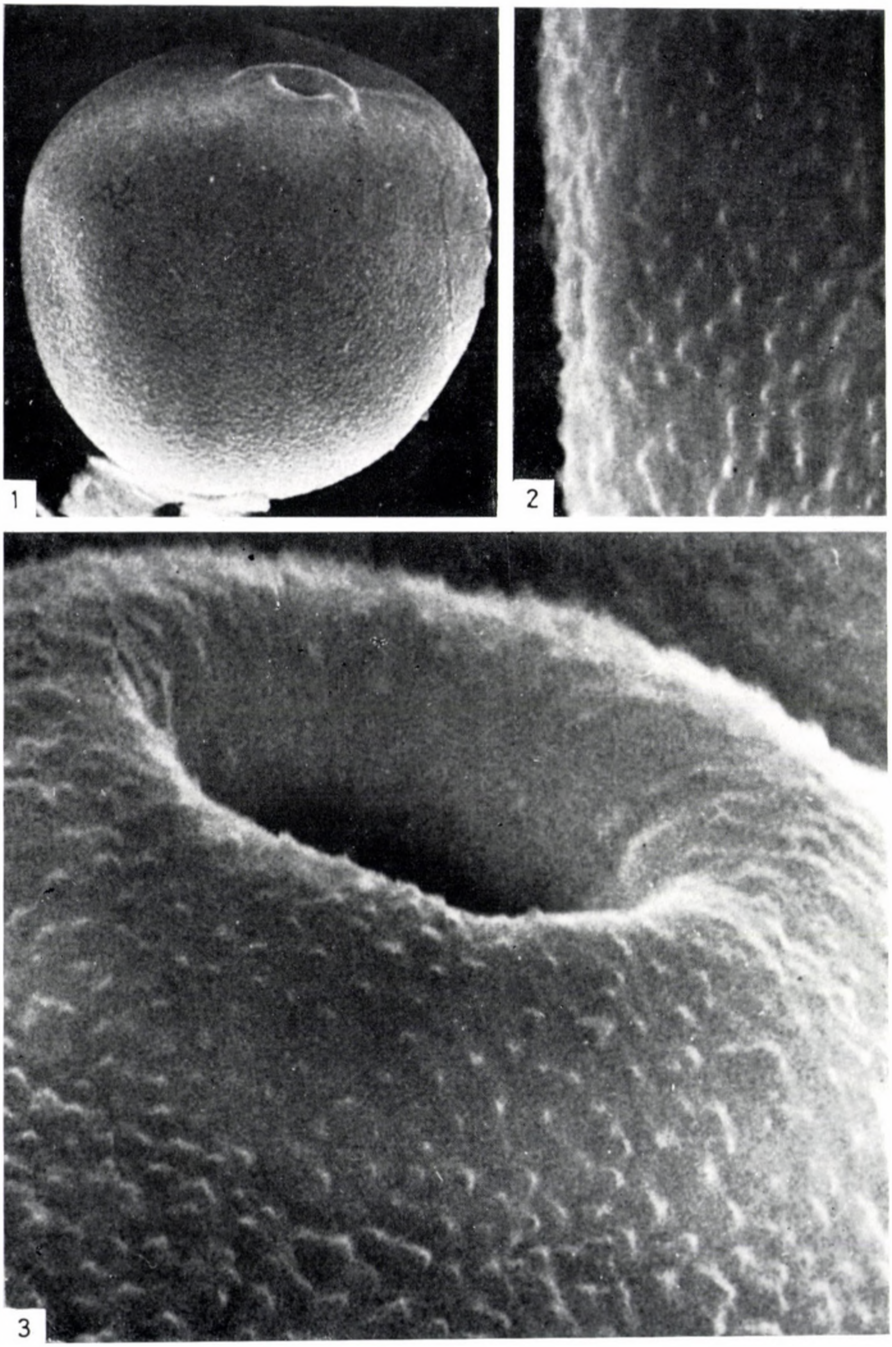
Cyperaceae have several pollen types. KRUTZSCH (1970) described only one of their genera under the name mentioned above. The morphological descriptions of this pollen type are different in the literature. According to ERDTMAN (1952) the apertures are poroid, of an ulcerate type, one of them lies on the broad end, while three of them lie laterally. KRUTZSCH (1970) designated the pore lying at the broad end as main pore, while the lateral ones as auxiliary pores, lacunae. According to MCANDREWS et al. (1973), these pollen grains are of periporate type, with three (4—6) lateral poroids, and with one poroid at the broad end of the pollen grain.

16. Cyperaceaepollis angolaensis n. fsp. (Pl. III, 6—13; Pl. V, 1—3).

Diagnosis: Laterally, the contour is elliptical, triangular or squariform with rounded off peak. Light microscopically, the surface is scabrous; electron microscopically, it is textate, perforate and ornamented with tiny coni. Light

Plate IV

1—3: Graminidites soellichauensis W. Kr. 1970
1: Surveying picture of pollen grain; ×1500
2: Submicroscopic sculpture of the extragerminal exine; ×15.000
3: Submicroscopic sculpture of the germinal exine; ×15.000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microscopically, the tri-partite separation of the exine is well observable. The exine thickness is around 1 μm, the three layers are by and large of identical thickness. The structure of the infratectal layer is pronounced; by the light microscope, its elements are columniform. At the broader end of the pollen grain there is one poroid aperture, laterally there are three. The one lying at the peak is wide, of an ellipsoid form and 6—7 μm maximum size. The lateral poroids are lying elongated, their length is around 10—15 μm, and again their diameter around 2—3 μm. Inside the poroids there are granular exine particles; these are probably of infratectal origin, with a small tectum remnant (Pl. V, 2, 3).

Maximum size: 22—30 μm.

Holotype: Pl. III, 6, 7, prep. Angola-III; 14.7/105.8.

Locus typicus: excavation along the river Lungue Bungo, Angola; Upper Pliocene.

Stratum typicum: Brown coal.

Derivatio nominis: after Angola.

Differential diagnosis: mainly the lateral poroids lying elongated differentiate it from the form-species described by KRUTZSCH (1970).

Occurrence: It is known with certainly only from the locus typicus, but it strongly resembles the pollen grains described by SAAD and SAMI (1967) as *Cyperus papyrus*, and by MEDUS (1975, Pl. X, 16, 17) as *Cyperaceae*.

Botanical relation: Cyperaceae, Cyperus; probably the form sphere of *C. papyrus*.

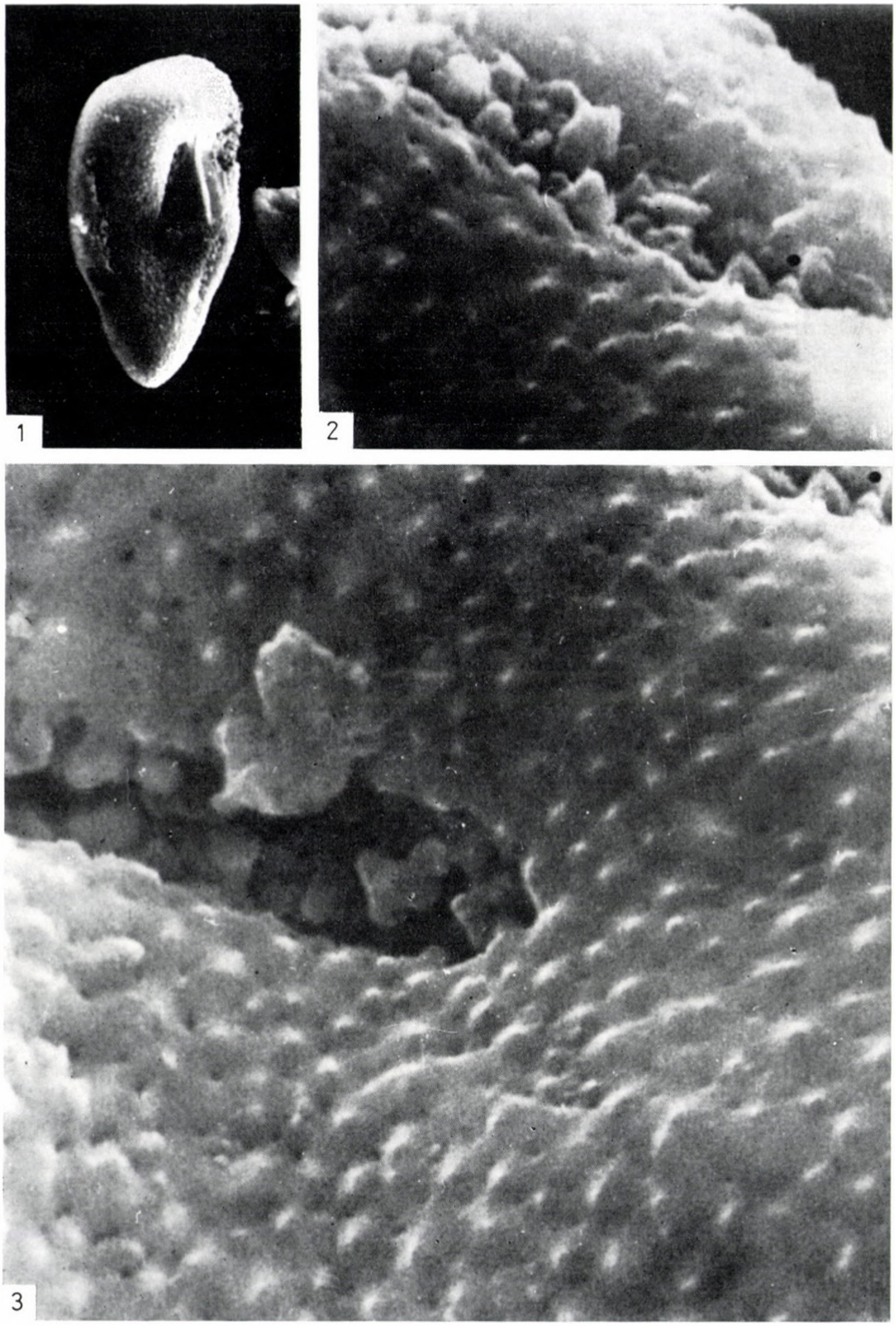
17. Cyperaceaepollis africanus n. fsp. (Pl. III. 14—19).

Diagnosis: Laterally, the contour is a triangle with strongly rounded off form; rarely, ellipsoid. The exine is tectate, perforate; the performations can well be recognized even by the light microscope. No further ornamentation of the tectum could be recognized. The tectum and the foot layer are of identical thickness; the infratectal layer is slightly thicker than the former two layers. The diameter of the exine is 1.5—2 μm. The infratectal structure is very pronounced, the layer consists of columnar elements. The columelles occasionally results in an (infra-)reticulate structure when viewed from above. The poroid lying at the broader end of the pollen grain, and the lateral poroids are by and large of identical size and ornamentation. Inside the poroids remnants of the exine are to be found; their form is ellipsoid, their size is 3.5—5 $\times$ 2 μm.

Maximum size: 16—22 μm.

Plate V

1—3: Cyperaceaepollis angolaensis n. fsp.
1: Surveying picture of pollen grain; $\times$1500
2, 3: Submicroscopic surface picture of the lateral poroids; $\times$15.000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Holotype: Pl. III, 14, 15, prep. Angola XVIII. 14.9/115.9.

Locus typicus: The excavation along the river Lungue Bungo, Angola; Upper Pliocene.

Stratum typicum: Brown coal.

Derivatio nominis: after Africa.

Differential diagnosis: The short lateral poroids and the thick wall differentiates it well from *C. angolaensis* n. fsp.; again the wall thickness and the essentially smaller size from the form species described by KRUTZSCH (1970).

Occurrence: For the time being it is known only from the locus typicus.

Botanical relation: Cyperaceae, cf. *Ascolepis.*

Note. — These forms were earlier reported under the name *Incertae* on the diagram (KEDVES and SIMONCSICS 1968).

18. Monogemmites pseudosetarius (Weyl. & Pf. 1957) W. Kr. 1970 (Pl. VI, 1, 2).

WEYLAND and PFLUG (1957) described it as *Smilax* or *Hydrocharia* pollen. According to KRUTZSCH (1970) it is rather a plankton organism. It frequently occurs in tetrads as well, but then it resembles *Droseraceae* pollen grains.

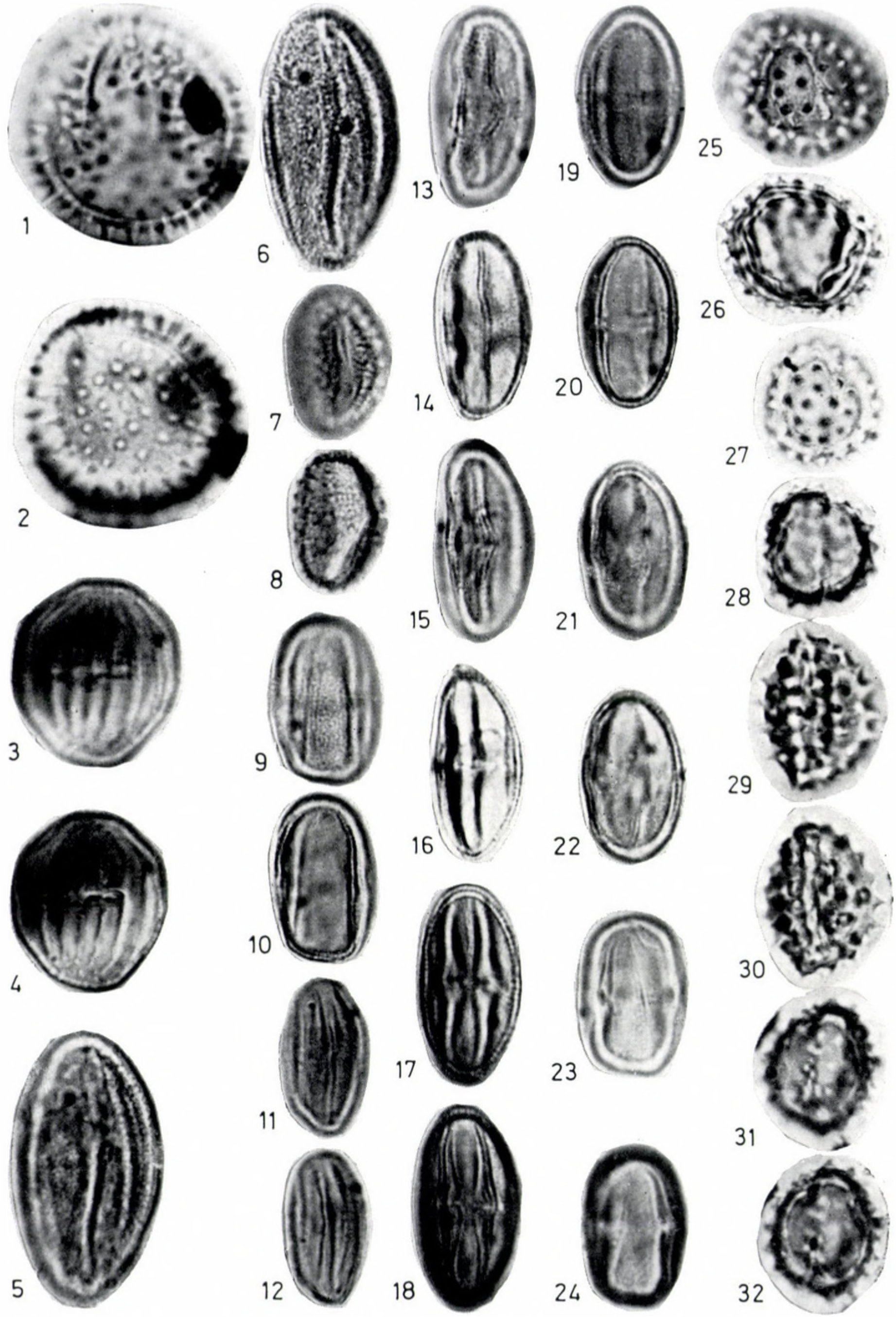
19. Polygalacidites Sah & Dutta 1966 sp. (Pl. VI, 3—4).

(Syn.: *Polygalacearumpollenites* E. NAGY, 1969.) BONNEFILLE (1969) reported pollen under the name *Polygala*, from recent deposits of Aouache. MEDUS (1975, Pl. X, 5—7) described similar forms under the name *Utricularia.* The pollen observed in our material is in relationship rather with the *Polygalaceae* family.

20. Tricolpites sp. (Pl. VI, 5, 6).

Plate VI

1, 2: Monogemmites pseudosetarius (Weyl. & Pf. 1957) W. Kr. 1970, prep. Angola XVIII; 13.5/116.6.
3, 4: Polygalacidites fsp., *Polygalaceae,* prep. Angola III; 4.9/112.8.
5, 6: Tricolpites sp., cf. *Caesalpiniaceae* v. *Fagaceae,* prep. Angola VI; 20.7/112.7.
7, 8: Ilexpollenites sp., *Aquifoliaceae,* cf. *Ilex,* prep. Angola IX; 20.9/121.4.
9, 10: Tricolporopollenites sp., *Araliaceae,* prep. Angola V: 12.3/106.2.
11, 12: Cupuliferoidaepollenites liblarensis (Thoms., in Pot., Thoms. & Thierg. 1950) R. Pot. 1960, *Fagaceae* v. *Leguminosae,* prep. Angola XX; 16.5/101.2.
13, 14: cf. *Umbelliferae,* prep. Angola III; 11.4/111.7.
15, 16: cf. *Umbelliferae,* prep. Angola V; 9.8/119.3.
17, 18: cf. *Umbelliferae,* prep. Angola X; 14.1/124.0.
19, 20: cf. *Umbelliferae,* prep. Angola XVI; 19.4/121.9.
21, 22: cf. *Umbelliferae,* prep. Angola X; 18.8/118.8.
23, 24: Sapotaceoidaepollenites communis Sah 1967, *Sapotaceae,* prep. Angola XVIII; 10.7/108.7.
25, 26: Tubulifloridites fsp. A, *Compositae, Tubuliflorae,* prep. Angola V; 5.6/116.4.
27, 28: Tubulifloridites fsp. A, *Compositae, Tubuliflorae,* prep. Angola IX; 22.4'106.6.
29, 30: Tubulifloridites fsp. B, *Compositae, Tubuliflorae,* prep. Angola I; 9.4'119.3.
31, 32: Tubulifloridites fsp. B, *Compositae, Tubuliflorae,* prep. Angola X; 15.2/110.6; ×1000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Tricolpate, intrabaculate; the exine tectate, perforate; the surface is ornamented with granulates. The exine is 1—1.5 μm thick; the infratectal columelle layer is much thicker at the tectum and the pedium; the latter two layers are of identical thickness. The colpi extend from peak to peak. Similar pollen grains occur in *Caesalpiniaceae* and *Fagaceae.*

21. Ilexpollenites sp. (Pl. VI, 7, 8). Tricolporoid pollen grains; the surface is of clavate ornamentation. The exine, in comparison with the pollen grain size, is thick, around 2 μm. The clavae continue in infratectal columellas; among the layers of the exine, the small heads of the clavae providing the tectum, and the columelle layer, are thick, the pedium is thin. *Botanical relation: Aquifoliaceae,* cf. *Ilex.*

22. Tricolporpollenites sp. (Pl. VI, 9, 10). Tricolporoidate, tricolporate pollen grains; the endopores seem weakly; they seem as geniculuses. The colpi in general reach the peaks of the pollen grain. Light microscopically, the tectum surface seems smooth. The tectum and the pedium are of identical thickness; the infratectal columelle layer is to a certain extent thicker than the former two layers. The exine thickness is around 1 μm.

Botanical relation: Unknown, possibly *Araliaceae.*

23. Cupuliferoidaepollenites liblarensis (Thoms. in Pot., Thoms. & Thierg. 1950) R. Pot. 1960, *Fagaceae* v. *Leguminosae* (Pl. VI, 11, 12).

SAH and DUTTA (1967) reported this form also from the Tertiary deposits of Assam. The pollen grain reported THIERGART and FRANTZ (1961) under the name of *Triporocolpatus indicus* also belongs in this sphere of forms. In the work mentioned, *Cupuliferae* is indicated as a botanical relation.

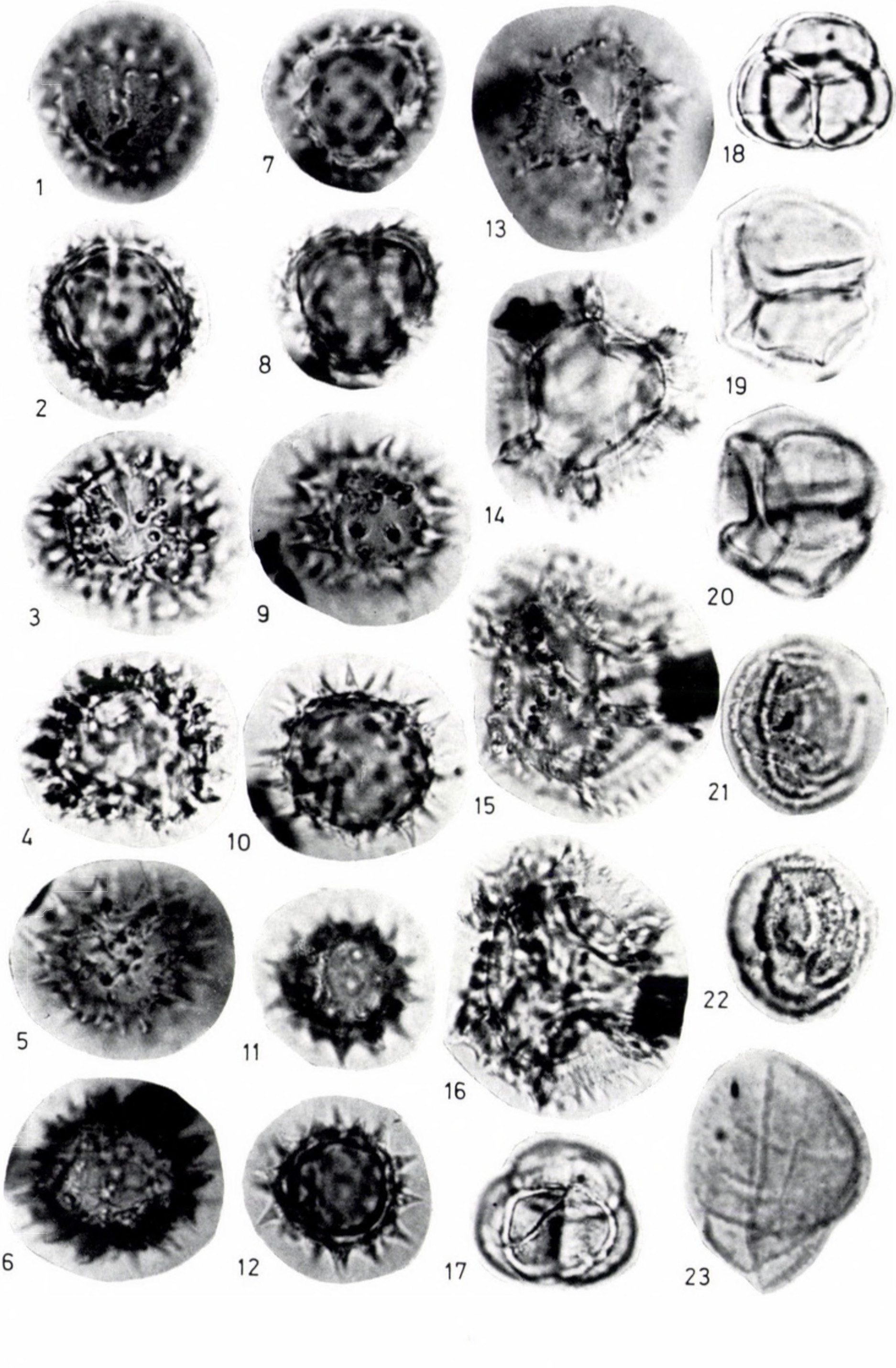
24. Cf. **Umbelliferae** (Pl. VI, 13—22).

In the wake of TING (1961), STRAKA et al. (1967), several genera of *Umbelliferae* can be taken into consideration; *Araliaceae, Cornaceae* and even *Euphorbiaceae* are not excluded either (VENKATACHALA and KAR 1968; VAN CAMPO et al. 1967).

25. Sapotaceoidaepollenites communis Sah 1967 (Pl. VI, 23, 24). *Sapotaceae.*

Plate VII

1, 2: Tubulifloridites fsp. C, *Compositae, Tubuliflorae,* prep. Angola III; 14.3/114.5.
3, 4: Tubulifloridites fsp. D, *Compositae, Tubuliflorae,* prep. Angola VI; 7.2'118.2.
5, 6: Tubulifloridites fsp. E, *Compositae, Tubuliflorae,* prep. Angola XI; 15.6/108.4.
7, 8: Tubulifloridites fsp. C, *Compositae, Tubuliflorae,* prep. Angola IX; 9.0'104.2.
9, 10: Tubulifloridites fsp. E, *Compositae, Tubuliflorae,* prep. Angola IV; 13.0/121.6.
11, 12: Tubulifloridites fsp. F, *Compositae, Tubuliflorae,* prep. Angola XV; 8.5/103.8.
13, 14: Cichoreacidites fsp. A, *Compositae, Liguliflorae,* prep. Angola IX; 20.4'119.6.
15, 16: Cichoreacidites fsp. B, *Compositae, Liguliflorae,* prep. Angola V; 19.7'102.4.
17, 18: Ericipites scabratus Sah 1967, prep. Angola VI; 9.3'119.2.
19, 20: Ericipites scabratus Sah 1967, prep. Angola XVII; 18.4'112.6.
21, 22: Eriocaulon sp. prep. Angola XI; 9.7/104.6.
23: Eriocaulon sp. prep. Angola XX; 12.7/117.4; ×1000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Gen.: **Tubulifloridites** (Cookson 1947) R. Pot. 1960.

In our material the genus is represented by several species. The botanical relation of all of them is *Asteraceae* (= *Compositae*, *Tubuliflorae*), without a possibility of nearer determination. The various types occured only in a few of the specimen materials.

26. Tubulifloridites sp. A (Pl. VI, 25—28).

27. Tubulifloridites sp. B (Pl. VI, 29—32).

28. Tubulifloridites sp. C (Pl. VII, 1, 2, 7, 8).

This pollen type is near to *T. kashmirensis* Thierg. and Frantz 1961.

29. Tubulifloridites sp. D (Pl. VII, 3, 4).

30. Tubulifloridites sp. E (Pl. VII, 5, 6, 9, 10).

31. Tubulifloridites sp. F (Pl. VII, 11, 12).

Gen.: **Cichoreacidites** Sah 1967

The synonym of the genus is *Fenestrites* (van der Hammen 1956) Germeraad et al. 1968. The genus summarized the pollen types of *Cichoriaceae* (= *Compositae*, *Liguliflorae*).

32. Cichoreacidites sp. A (Pl. VII, 13, 14).

33. Cichoreacidites sp. B (Pl. VII, 15, 16).

Gen.: **Ericipites** Wodehouse 1933

Besides the origination of the pollen tetrads from *Ericaceae*, other genera can also be taken into consideration.

34. Ericipites scabratus Sah 1967 (Pl. VII, 17—20).

The type described by Sah (1967) is well in agreement with that of Angola.

35. Eriocaulon sp. (Pl. VII, 21—22 and 23).

According to Erdtman (1952), certain pollen grains of the *Eriocaulaceae* genus are spiraperturate. The surface is sporadically ornamented with fine spinae. On the basis of these rare characters of the association, our pollen grains represent the *Eriocaulon* genus. The microfossils of the genus were also obtained from the Eocene of Colorado, and the Pliocene of Canada, while the pollen of *Eriocaulon septangulare* from the interglacial deposit of Riss—Mindel, Ireland (Engler 1964).

Planktonites

The forms of the *Concentricystes* genus occur in a relatively large number in the specimens. The light and electron microscopical examinations of these are dealt with in a small separate publication. It is not entirely excluded that they indicate fluviatile conditions.

III. Flora and vegetation

On the basis of the detailed palynological analysis, in the Angolan brown coal recent taxa determined up to the following depths occur as:

Pteridophyta
- *Lycopodiaceae*
- *Polypodiaceae* (*Thelypteridaceae*)

Gymnospermatophyta
- *Podocarpaceae, Podocarpus* (*gracilior*)
- ? *Cycadales*

Angiospermatophyta — Dicotyledonopsida
- ? *Fabaceae* (*Papilionaceae*)
- *Caesalpiniaeeae*
- *Aquifoliaceae, Ilex*
- ? *Araliaceae*
- *Apiaceae* (*Umbelliferae*)
- *Euphorbiaceae*
- ? *Droseraceae*
- *Asteraceae* (*Compositae — Tubuliflorae*)
- *Asteraceae* (*Compositae — Liguliflorae*)
- *Ericaceae*
- *Sapotaceae*
- *Myricaceae*

Angiospermatophyta — Monocotyledonopsida
- *Cyperaceae: Cyperus* (*papyrus*)
- *Cyperus v. Ascolepis*

Eriocaulaceae, Eriocaulon
Poaceae (*Gramineae*)
? *Restionaceae*
Arecaceae (*Palmae*), *Phoenix* (*reclinata*)

According to the large-scale quantitative analysis dealt with in our preliminary study (Kedves and Simoncsics 1968) the origin of the sporomorphae can be given as follows:

53% from *Cyperus papyrus* form sphere,
7% from other *Cyperus* or *Ascolepis* species,
35% from ***Poaceae*** (***Gramineae***) species,
5% from other taxa.

On the basis of the detailed quantitative and the above qualitative data, and the work of Knapp (1973), in which African vegetation is discussed, we attempt now to enumerate those associations which possible took part in the formation of coal, and to reconstruct those associations which surrounded swamps and from which pollen material went into swamps.

Associations which are presumed to belong here: (a) Papyrus swamp; (b) grassland; (c) riverine and gallery forests and woodlands; (d) dwarf plant swamp.

In all probability, the coal-forming swamp was Papyrus swamp. These swamps are at present extremely poor in species. Besides the dominant ***Cyperus papyrus***, other ***Cyperaceae*** species, a few of ***Poaceae*** (***Leersia***) species, individual ***Ipomoea*** and *Alisma* species occur in them. In the case of a development rich

in dicotyledons and ferns, there occur also *Menispermaceae*, *Melastomataceae*, ***Polygonaceae***, and also *Thelypteridaceae* species in these swamps.

Papyrus swamps are indicated by *Cyperaceae* sp. and *Polypodiaceae* (*Thelypteridaceae*) fsp. from the sporomorphae of Angolan coal.

On account of the indeterminedness of the *Poaceae* (*Gramineae*) pollen types within the family, a more accurate analysis of the grassland meets with difficulties. There is a high probability that the pollen material originates from the ancestor of the present grassland with numerous ***Compositae*** of the Highlands. Today, this grassland is of a wide extension to the south from the Sahara in an East–West direction; to the south down to Angola. Its characteristic is an altitude of 1000—1500 m, a quantity of 1000—1300 mm annual moisture and the shallow rocky gritty soil. Together with several ***Poaceae*** species (*Adropogon*, *Ctenium*, *Diectomis*, *Melinis*, *Loudetia*, *Monocymbium*), there occur in this grassland numerous *Asteraceae* (*Compositae*) genera (*Echinops*, *Guizotia*, *Senecio*, *Vernonia*), as well as *Fabaceae* (*Papilionaceae*) species from (*Crotalaria*, *Eriosema* and *Rhynchosia* genera) and *Lamiaceae* (*Labiatae*), from the *Apiaceae* (*Umbelliferae*), the *Diplolophium*, *Lefebvrea*, *Pimpinella*, *Pycnocycla* species, individual *Acanthaceae*, *Melastomataceae*, *Ascelpiadaceae*, *Santalaceae* and *Polygalaceae* (*Polygala*) species.

In our material, ***Poaceae*** are indicated by 6 types (possibly one ***Restionaceae***), while *Fabaceae*, *Apiaceae* and *Polygalaceae* by one type each. Naturally, it is not excluded that the sporomorphae, originate from other grasslands occuring on the shores of drier islands of Papyrus swamps; possibly, ***Phragmites*** which is water-bound may also be mentioned.

We consider it likely that the ancestor of the river Lungue Bungo was lined by gallery forests. The moistureus vegetation, occuring also in the present Zambesi valley, is very rich in genera and species of riverine and gallery forests and woodlands. Their main characteristic is the richness in palms and *Sapotaceae*. Presumably, the pollen which indicates *Phoenix* (*P. reclinata*), the pollen types originating from *Sapotaceae* (*Mimusops*, *Afroserlisia*, *Englerophyton*, *Vincentella*), the *Caesalpiniaceae* (*Berlinia*) and the *Euphorbiaceae* (*Hymenocardia*) pollen, which is indicated in our material as possible, — all these may have got from gallery forests into the coal-forming swamp.

On the basis of the sporomorphae, the dwarf plant swamp also seems to be reflected the character species of which are *Eriocaulon* species. These are as a matter of fact such swamps that were formed in rocky valleys of island mountains, or in depressing covered with laterite, in very thin, finely granulated soil. The species however remain dwarf due to lack of nourishment.

At present they are most typically developed in West Africa. In our material, besides the *Eriocaulon* genus giving the character species, the *Polygala*, possibly *Drosera* and *Cyperus* genera are in agreement with the genera of the grassland. Assumably, some of the pollens of this grassland were also washed

in the swamp which collected the sedimentation and formed the peat (coal).

In addition to one-two indefinitely determined other pollen types, *Podocarpus* pollen is also worthy of mention; it can be considered as closely related to *P. gracilior*. Today, in the mountainous regions of East Africa and in South Africa there occur *Podocarpus* forests rich in genera and species. A relationship on the basis of pollen types (for example by means of an *Ilex* and possibly an *Araliaceae* type pollen) with the *Podocarpus* forests of the E-African mountains, in which the *P. gracilior* is the characteristic species, is so indefinite that we think it likely that these forest types were far from the valley of Lungue Bungo also at that time.

IV. Summary

1. The present paper, on the basis of a detailed palynological analysis, pointed out 35 spore pollen types and 1 plankton deposit from the brown coal occurring in the valley of Lungua Bungo river in Angola. Among them, new species are *Megaporoites angolaensis* n. fsp., *Graminidites magnianulatus* n. fsp., *Cyperaceaepollis angolaensis* n. fsp. and *Cyperaceaepollis africanus* n. fsp.

Owing to shortage in specimens, no morphological description has been prepared on a spiraperturate pollen which however undoubtedly represent the *Eriocaulon* genus.

Among the pollen types described by other authors, the following are of African or South-East Mediterranean origin: *Podocarpidites* fsp. (*P. gracilior* type), *Graminidites assamicus* Sah & Dutta, *Graminidtes congoensis* Sah.

The *Cyperus* papyrus pollen described by SAAD and SAMI (1967) from Norh Africa is likely to be probably in agreement with the *Cyperaceaepollis angolaensis* n. fsp. Further African pollens are *Polygalacidites* Sah and Dutta gen., the form of *Cupuliferoidaepollenites liblarensis* described by SAH and DUTTA from Assam, the *Sapotaceoidaepollenites communis* Sah and the *Ericipites scabratus* Sah.

2. During the examinations, the SEM investigations of *Graminidites soelichauensis* and of *Cyperaceaepollenites angolaensis* were also carried out. On their electron microscopic sculpture, the authors have given their report in the course of describing and diagnosing the above species.

3. On the basis of the sporomorphae, the authors succeeded in establishing 22 recent *Cormophyta* taxa; up to family 14, subfamily 2, genus 3, species 3 taxa.

4. On the basis of quantitative data of recent taxa and sporomorphae, the coal forming vegetation was *Cyperus papyrus* swamp. A grassland near

the swamp, probably with numerous *Compositae*, and also a gallery forest, are reflected in the deposit catcher. The dwarf plant swamp characterized by *Eriocaulon* species seems of farther origin, and the one-two pollens of the *Podocarpus* (*gracilor*) forest of the mainly highland mountains could be transported into the swamp giving the coal from even farther distances.

5. The more detailed data allow us to conclude that at the time of coal-formation this area may have been of a climate similar to that existing there today but richer in moisture; the Upper Tertiary–Quarternary limit of coal-formation, and even its Lower Quaternary age, are not excluded either.

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THE EFFECT OF HARDENING ON THE IAA-OXIDASE ISOENZYME PATTERNS IN WINTER WHEAT CULTIVARS WITH VARYING DEGREES OF COLD HARDINESS

By

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The connection between growth intensity and frost hardiness was examined in wheat cultivars with varying degrees of frost hardiness. On the basis of the experiments presented in this paper it can be concluded that there is an inverse relationship between growth intensity and frost tolerence in the different wheat cultivars. This fact is supported by an increased IAA-oxidase enzyme activity at low temperature and by the isoenzyme synthesised "de novo" after cold treatment. The result obtained indicate that the IAA-oxidase system is adapted to the low temperature conditions in the frost hardy wheat varieties. The mechanism of this adaptation seems to be very complex and needs further research.

Introduction

According to earlier physiological and biochemical investigations carried out on frost hardiness, it can be concluded that generally the hardiest cultivars proved to be those in which the minimum temperature of photosynthesis was around 0 °C or lower, a considerable part of the assimilates was translocated into the roots, and the intensity of cell division and plant growth decreased sharply as a function of the falling temperature and practically ceased at temperatures near the freezing point (Dévay 1962; Dévay 1965; Dévay and Rajki 1972; Fehér and Dévay 1975; Dévay and Fehér 1975).

Taking into consideration that the growth processes occuring at low temperature have their own, special role in developing the degree of frost hardiness in winter wheat cultivars, the biochemical background of this mechanism, including the investigation of the Indole-acetic acid oxidase (IAA-oxidase) system which controls the growth of plants by oxidizing the endogenous auxin (IAA), was studied, since very little is known in this field.

Bolduc et al. (1970) detected a 10-fold increase in IAA-oxidase activity in winter wheat seedlings during 40 days' cold treatment. According to their results the enzyme activity increased sharply during the first 10 days in the cold and progressed slowly from the 10th to 40th days. Krasnuk et al. (1975) investigated the change in the electrophoretic pattern of IAA-oxidase in alfalfa due to the cold effect, described qualitative differences in the patterns

of cold-hardy and cold sensitive varieties and reported an increased enzyme activity in IAA-oxidase assays during hardening.

This paper discusses the connection between the growth intensity and frost hardiness in different wheat cultivars having different abilities to survive the cold effect, and also deals with the temperature induced changes of IAA-oxidase with particular reference to the cold inductibility and isoenzyme pattern of the enzyme.

Materials and methods

Plant material: The experiments were carried out on wheat cultivars with varying degree of frost hardiness: *Bezostaya 1, Martonvásári 2, Odeskaya 16, Mironovskaya 808, Minhardi, Bánkuti 1201, Odeskaya 51, Fertődi 293, Grana, Orlando, Luna, Sonora 64, Rusalka, Kasticka, Trumph.* Data concerning the degree of frost hardiness in these varieties are summarized in Table 1.

Determination of growth intensity: The cell elongation was measured in coleoptile test. 5 mm long coleoptile segments were cut out of 4-day-old seedlings germinated at 25 °C in a dark room, and were incubated for 72 hours at 5 °C in 1% sucrose solution. Data are expressed as the percentage values of the control.

Determination of IAA-oxidase activity: Wheat germs were homogenized in cold phosphate buffer (pH = 5.0) and the enzyme activity was determined from the crude enzyme extraction by the modified method of GORDON and WEBER (1951). The quantity of soluble protein was determined according to LOWRY et al. (1951). The activity of the enzyme was expressed as the ratio of μg residual IAA/mg protein/hour.

Table 1

Degrees of frost hardiness in different wheat cultivars

Cultivars	Degree of frost hardiness*
Trumph	30.5
Kasticka	31.5
Rusalka	32.1
Sonora 64	34.9
Luna	41.3
Orlando	48.7
Grana	49.3
Fertődi 293	50.0
Odeskaya 51	63.3
Bánkúti 1201	65.0
Minhardi	67.8
Mironovskaya 808	67.9
Odeskaya 16	72.5
Martonvásári 2	77.2
Bezostaya 1	81.6

* Degree of frost hardiness: the percentage survival of cold treatment at temperature −14 °C (KOCH 1975, BALLA 1975)

Determination of IAA-oxidase isoenzyme pattern: Wheat germs were homogenized in cold 0.1 M Tris-HCl buffer (pH = 8.0), containing 0.5 M sucrose, 0.006 M ascorbic acid and 0.006 M cysteine hydrochloride. After sonication and centrifugation 200 μl crude extract was used to determine the enzyme pattern. The isoelectric focussing was performed in 0.5 × 7.0 cm polyacrylamide gels using LKB Carrier Ampholites with pH in the range 3—10 and chemical polymerization was carried out according to WRIGLEY (1968). The isoenzyme activities were determined at incubation temperatures of 5 °C and 25 °C. The activity of the isoenzymes is proportional to the intensity of the bands visualized according to ENDO (1968) on the basis of equal protein content and are presented in diagrams and scannograms made with a JOYCE LOEBL Chromoscan at a magnification 1 : 3.

Results

1. The relationship between growth intensity and frost hardiness: The intensity of cell elongation was determined in a coleoptile test at 5 °C after 72 hours' incubation. Figure 1 shows the correlation between the cell elongation of the cultivars and the degree of frost resistance given as percentage survival. The regression is sharp: −0.83, which represents a strong correlation between growth intensity and frost hardiness in wheat cultivars with varying degrees of cold hardiness.

2. The temperature inductibility of IAA- oxidase activity: The activity of IAA-oxidase was determined in crude enzyme extract at incubation temperature of 0, 5, 10 and 15 °C in frost-hardy winter wheat varieties. The enzyme extraction was made from germs germinated at 25 °C before and after hardening. The data are summarized in Fig. 2. At an incubation temperature of 5 °C the IAA-oxidase had a relatively high activity and cold treatment on the germ had the effect of increasing the activity of the enzyme. The cold-induced

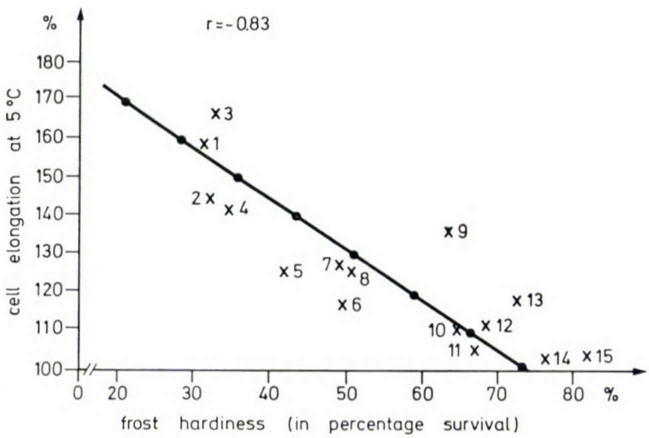

Fig. 1. Correlation between frost hardiness and growth intensity at 5 °C. 5 mm long coleoptiles were cut out of 4-day-old seedlings germinated at 25 °C. Wheat cultivars examined: *Trumph* (*1*), *Kasticka* (*2*), *Rusalka* (*3*), *Sonora 64* (*4*), *Luna* (*5*), *Orlando* (*6*), *Grana* (*7*), *Fertődi 293* (*8*), *Odeskaya 51* (*9*), *Bánkuti 1201* (*10*), *Minhardi* (*11*), *Mironovskaya 808* (*12*), *Odeskaya 16* (*13*), *Martonvásári 2* (*14*), *Bezostaya 1* (*15*)

increase could not be observed at high temperature (15 °C). The temperature dependence of cold-induced IAA-oxidase activity seems to be about 5 °C (Fig. 2) and the formation of the enzyme could be inhibited by 500 ppm chloramphenicol (CAP) treatment (Fig. 3).

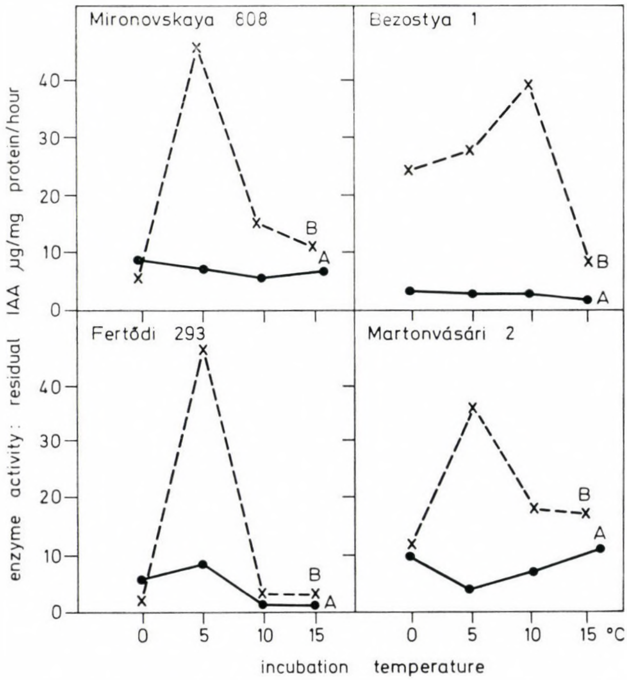

Fig. 2. Temperature dependence of IAA-oxidase activity. The activity was determined before (A) and after (B) hardening. IAA-oxidase was extracted from two-day-old wheat germs. Hardening: germs were kept at 0 °C in a refrigerator for 5 days

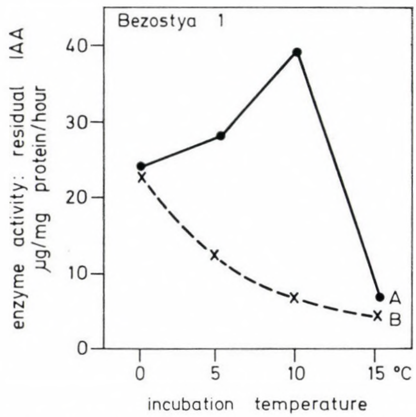

Fig. 3. The effect of chloramphenicol (CAP) on the cold-induced increase of IAA-oxidase activity. CAP treatment was applied as a spray (concentration: 500 ppm) on two-day-old germs before hardening. A: control germs exposed to 5 days' cold treatment. B: material treated by CAP

3. *The change of IAA-oxidase isoenzyme pattern:* The isoenzyme pattern of the enzyme was examined in crude extract by isoelectric focussing method. The extract originated from two-day-old germs before and after the 5 day hardening period. Figures 4 and 5 show scannograms of IAA-oxidase isoen-

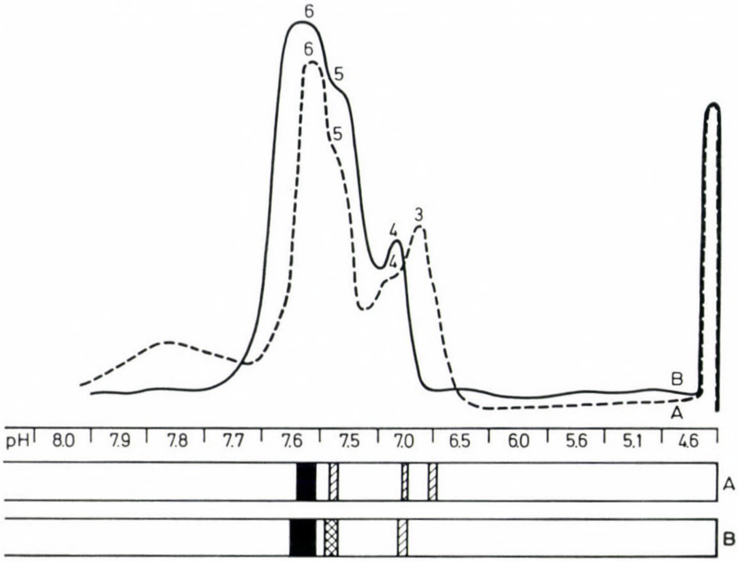

Fig. 4. IAA-oxidase isoenzyme pattern active at 25 °C (A), and 5 °C (B) in *Bezostaya* 1 winter wheat germs before hardening. The isoenzymes were separated by isoelectric focussing method and visualized according to ENDO (1968). (See in Materials and methods)

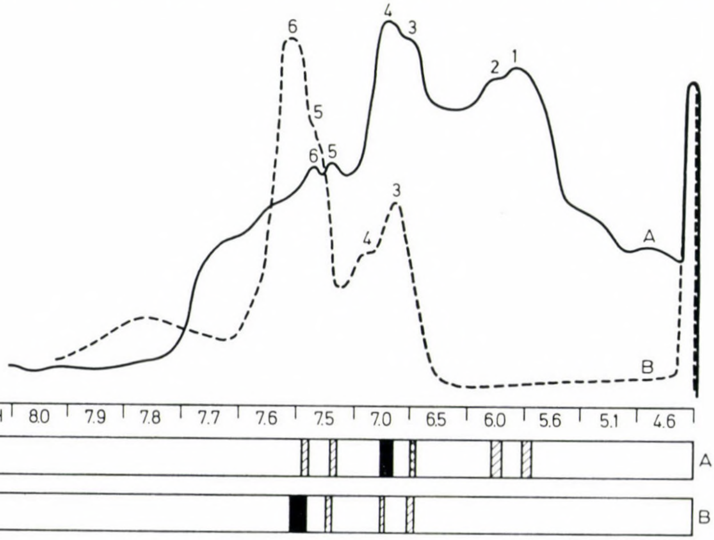

Fig. 5. The effect of hardening on the IAA-oxidase isoenzyme pattern at 5 °C before (A) and after (B) hardening in *Bezostaya* 1 winter wheat germs. The isoenzymes were separated by isoelectric focussing method and visualized according to ENDO (1968). (See in Materials and methods)

zymes. In *Bezostaya* 1 frost-hardy winter wheat 6 isoenzyme bands active at 25 °C were detectable, but only a few of these were active at a 5 °C incubation temperature (Fig. 4). The cold treatment increased the activity of bands 4, 5 and 6 active at low temperature, especially in the case of 6th band, while the 3rd band lost its activity during hardening.

Discussion

The data obtained in these experiments between growth intensity and frost hardiness are supported by earlier results describing the relation between cell division and frost hardiness (DÉVAY 1962). NIKOLOV and SALCHEVA (1969) also noted a reduction of the growth processes in overwintering plants. Not only the increased intensity of cell division, but the increased cell elongation at low temperature is also connected with a lower rate of frost hardiness, while by contrast the lower growth intensity is associated with a higher rate of frost hardiness.

Is is well-known that the primary regulator of the intensity of cell elongation is a function of IAA-oxidase affecting the endogenous IAA level in plants. The decrease in growth intensity is probably connected with the frost hardiness of the plants and is thus one result of the metabolical processes occuring at low temperature. However, data have not yet been published on the activity of IAA-oxidase at low temperature.

According to BOLDUC et al. (1970) experiments a 10-fold increase in the activity of IAA-oxidase could be detected in winter wheat after a 40 day cold treatment. KRASNUK et al. (1975) demonstrated mainly qualitative differences in the isoenzyme pattern of cold hardy alfalfa and increased enzyme activity after cold treatment. Since it has been proved that both vernalization and hardening processes are initiated only at low temperatures near the freezing point, only those enzymes can take part in these processes which are also active at low temperature. In this respect the experiments of BOLDUC et al. (1970) do not elucidate the proper relationship between hardening processes and IAA-oxidase activity, because in their experiments the enzyme activity was determined only at high temperature.

On the supposition that not only one IAA-oxidase isoenzyme can be found in wheat germs the activity of the enzyme was determined at different temperatures. The temperature induced changes in the kinetics of the reaction catalyzed by the enzyme could due to different parameters. Several examples of temperature changes in the activity of membrane-associated enzymes have been described as a change in the membrane structure (MCMURCHIE et al. 1973; RAISON 1972; SCHNEYOUR et al. 1973). Since the IAA-oxidase investigated was in soluble form the temperature-induced change could not be inter-

preted as an action of the membrane structure in our system. So we postulated a change in the isoenzyme pattern as an effect caused by the falling temperature.

The temperature dependence of IAA-oxidase activity and cold induced changes in the activity raised the possibility of "de novo" synthesis of IAA-oxidase isoenzymes active at low temperature. Experiments concerning the change in the isoenzyme pattern due to the effect of hardening also supported this hypothesis. Not all the IAA-oxidase isoenzymes detected in wheat germs are active at both low and high temperatures. The cold inductibility of the enzyme activity could be detected only in the case of isoenzymes active at low temperature.

On the basis of the experiments presented in this paper it can be concluded that there is an inverse relationship between the growth intensity and frost-tolerance in the different wheat cultivars. This fact is supported by an increased IAA-oxidase activity at low temperature and by a new isoenzyme synthetised "de novo" after the cold treatment. The results obtained indicate that the IAA-oxidase system is adapted to the low temperature conditions. The mechanism of this adaptation seems to be very complex and needs further research.

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ANHÄUFUNG VON ELEMENTEN IM BALATONER SCHILFROHR *(PHRAGMITES COMMUNIS)*

By

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(Angekommen am 12. September, 1977)

In der Uferzone des Balaton wurde im Blatt, Halm, Rhizom, sowie in den Wurzeln und Wurzelhaaren (miteinbegriffen auch die flaumhaarigen Adventivwurzeln) des Schilfrohrs die Quantität der Polyelemente (N, P, Ca, K, Mg, Fe) und die der Oligoelemente (Mn, Zn, Sr, Cu, Pb) untersucht.

Aufgrund des Prozentwertes der Trockensubstanz häufen sich von den untersuchten Teilen die Polyelemente im Blatt und im Wurzelhaar (implicite Adventivwurzel) auf, darauf folgen in abnehmender quantitativer Reihenfolge die Wurzeln, das Rhizom und der Halm; hinsichtlich der Oligoelemente gestaltet sich die Reihenfolge folgendermaßen: Wurzelhaar (Adventivwurzel), Wurzel, Blatt, und endlich Rhizom und Halm.

Der Halm und das Rhizom, bzw. die Wurzel und das Wurzelhaar des Rohrs enthalten die angehäuften Elemente in ähnlicher Menge und Proportion. Das Blatt — was die absoluten Stoffmengen anbetrifft — weicht von allen übrigen Organen ab, und ist — was die Proportionen anbelangt — vor allem dem Stengel ähnlich.

Einführung

Im Botanischen Forschungsinstitut der Ungarischen Akademie der Wissenschaften sind seit mehreren Jahren Untersuchungen die biogenen Elementenzirkulation und Nährstoffbilanz des Balaton-Sees betreffend angestellt worden. Die Grundlage zu diesen Studien bildet die Elementenakkumulation der häufiger auftretenden Wasserpflanzen (Laichkraut-Arten, Rohr, Rohrkolben, Binse usw.). Die Zielsetzungen der Forschungen bestehen im folgenden:

— inwiefern ist die Akkumulation der einzelnen Elemente eine Eigentümlichkeit der gegebenen Art, in welchem Masse hängt jene von der Kationselektionsfähigkeit und von der geochemischen Umgebung ab;

— in welcher Quantität häuft sich in den einzelnen Pflanzenarten, bzw. in den verschiedenen Organen der Pflanzenarten das in der Eutrophisation des Sees die Hauptrolle spielende Stickstoff und der Phosphor an, wie bedeutend ist die sog. biologische Filterwirkung, bzw. was ist ihre Rolle in der Selbstreinigung des Wassers;

— in welcher Quantität häufen sich in den einzelnen Pflanzenarten die durch die Pollution ins Wasser gekommenen Schwermetalle an.

Die Röhrichte der Uferzone des Balaton sind wichtig, weil sie:

1. die natürliche Nährstoffnachfuhr des Sees sichern,

2. als eine Schutz- bzw. Filterzone an den Stellen funktionieren, wo Abwässer in den See geraten; das Röhricht am Ufer hält die verschiedenen Schmutzstoffe zurück (Tóth, 1972),

3. das Röhricht akkumuliert in bedeutendem Masse die ins Wasser und ins Sediment gekommenen Nährstoffe, der gebundene Nährstoff kann von anderen Pflanzen (Laichkräuter, Algen) nicht aufgenommen werden. Während des Abbaus des organischen Materials des Schilfrohrs werden die biogenen Elemente mit verschiedener Geschwindigkeit frei (Kovács, 1976) und demnach belasten sie das Wasser des Sees stufenmäßig.

Material und Methode

Die Probeentnahmen vom Schilfrohr wurden am 7—8. August, 1975 und am 5—6. Juli, 1976 an folgenden Orten durchgeführt: Fonyód—Bélatelep, Balatonberény, Balatonszentgyörgy, Fenékpuszta, Gyenesdiás, Vonyarcvashegy, Balatongyörök—Balatonederics, Szigliget, Badacsony, Révfülöp, Balatonszepezd, Balatonudvari, Tihany—Balatonfüred, Balatonfüzfő—Balatonkenese. Die Zone der Probeentnahmen befand sich in einer Wassertiefe von 50—80 cm. Es wurden in beiden Jahren je 11 Proben untersucht. Von jeder Stelle wurden je 10 Pflanzenindividuen gesammelt und das Material wurde nach sorgfältiger Reinigung und Abwaschung mit destilliertem Wasser in die verschiedenen Pflanzenorgane geteilt (Blatt, Halm, Rhizom, Wurzel, Wurzelhaar). Aus den Pflanzenmaterialien wurden je zwei sog. gemischte Proben verfertigt und diese in zweifacher Wiederholung im Laboratorium bearbeitet.

Die Bestimmung sämtlicher Stickstoffproben geschah mit Hilfe der Kjehldahlschen Zertrümmerung, der P-Gehalt wurde mit der Di Gleria-Methode (1951) bestimmt. Die Untersuchung von Ca, K und Na ist mittels eines Flammenphotometers, die von Mg, Fe, Mn, Zn, Sr, Cu und Pb dagegen mittels eines Unicam Atomabsorptions-Spektrophotometers vorgenommen worden.

Laut den Literaturangaben (vgl. Bayly—O'Neill 1972, Kvet 1973, Mochnacka—Lawacz 1974, Dykyjova—Hradecká 1976, usw.) ändert sich die chemische Zusammensetzung des Schilfrohrs in der Vegetationsperiode, und so wurden nur die zu gleichem Zeitpunkt entnommenen Proben verglichen. Tabellen 1 und 2 enthalten auch die Mittelwerte der chemischen Zusammensetzung der verschiedenen Organe der je 11 Proben (ausser den Ergebnissen des *t*-Tests), auf die Trockensubstanz bezogen.

Zum Vergleich des absoluten Elementengehalts der Organe wurde die Distanzfunktion von Euklid angewandt. Ist die Zahl der untersuchten Elemente n, so können die Organe als Punkte in einem Raum mit n-Dimension aufgefasst werden, wo die Koordinaten des mit j bezeichneten Organs die Probendurchschnitte der Elemente darstellen (X_{ij}, $i = 1, 2 \ldots n$).

Die Distanz zwischen den Organen j und k ist nach Euklid, wie folgt:

$$E_{j,k} = \sqrt{\sum_{i=1}^{n} (X_{ij} - X_{ik})^2}\ .$$

Der Wert von $E_{j,k}$ hängt von den absoluten Quantitäten ab, demnach zeigt er keine obere Grenze.

Mit Berücksichtigung der Proportion der Elemente, mag die Distanz zwischen zwei Organen folgendermassen definiert werden (»chord distance«, Orlóci 1975):

$$C_{j,k} = \sqrt{2\left(1 - \frac{Q_{jk}}{\sqrt{Q_{jj}\,Q_{kk}}}\right)}$$

Tabelle 1

Vergleichungstabelle der Mittelwerte des Gehalts an biogenen Elementen der verschiedenen Teile des Schilfrohrs (Phragmites communis)
(Daten aus 1975)

Schilfrohrorgane	Biogene Elemente	Mittelwert (n=11) bezogen auf die Trockensubstanz	Halm	Rhizom	Wurzel	Wurzelhaar (Adventiv-wurzel)
Blatt	N %	3,13	+	+	+	+
	P %	0,13	+	+	+	+
	Ca %	0,22	NS	NS	+	+
	Mg %	0,33	+	+	+	+
	K %	1,13	+	NS	+	+
	Na %	0,02	NS	+	+	+
	Mn ppm	166,00	+	+	+	+
	Zn pp,	22,00	NS	NS	+	+
	Fe ppm	136,00	NS	NS	+	+
Halm	N %	0,83	—	+	NS	+
	P %	0,07	—	NS	NS	+
	Ca %	0,09	—	NS	+	+
	Mg %	0,13	—	NS	+	+
	K %	0,89	—	NS	+	+
	Na %	0,05	—	NS	+	+
	Mn ppm	59,00	—	NS	+	+
	Zn ppm	17,00	—	NS	+	+
	Fe ppm	120,00	—	NS	+	+
Rhizom	N %	0,55	—	—	+	+
	P %	0,06	—	—	+	+
	Ca %	0,17	—	—	+	+
	Mg %	0,20	—	—	+	+
	K %	0,95	—	—	+	+
	Na %	0,08	—	—	+	+
	Mn ppm	57,00	—	—	+	+
	Zn ppm	14,00	—	—	+	+
	Fe ppm	300,00	—	—	+	+
Wurzel	N %	0,85	—	—	—	+
	P %	0,09	—	—	—	NS
	Ca %	0,75	—	—	—	+
	Mg %	0,47	—	—	—	NS

Fortsetzung Tabelle 1

Schilfrohrorgane	Biogene Elemente	Mittelwert (n=11) bezogen auf die Trockensubstanz	Halm	Rhizom	Wurzel	Wurzelhaar (Adventiv-wurzel)
	K %	0,64	—	—	—	NS
	Na %	0,19	—	—	—	NS
	Mn ppm	253,00	—	—	—	+
	Zn ppm	37,00	—	—	—	+
	Fe ppm	1390,00	—	—	—	NS
Wurzelhaar (Adventivwurzel)	N %	1,23	—	—	—	—
	P %	0,10	—	—	—	—
	Ca %	1,39	—	—	—	—
	Mg %	0,45	—	—	—	—
	K %	0,44	—	—	—	—
	Na %	0,14	—	—	—	—
	Mn ppm	402,00	—	—	—	—
	Zn ppm	55,00	—	—	—	—
	Fe ppm	1842,00	—	—	—	—

+ = es besteht eine signifikante Differenz auf dem Wahrscheinlichkeitsniveau von P = 5%

NS = es besteht keine signifikante Differenz auf dem Wahrscheinlichkeitsniveau von P = 5%

wo

$$Q_{jk} = \sum_{i=1}^{n} X_{ij} X_{ik}\,; Q_{jj} = \sum_{i=1}^{n} X_{ij}^2; Q_{kk} = \sum_{i=1}^{n} X_{ik}^2 .$$

Wenn die zwei verglichenen Organe alle Elemente in gleichem Verhältnis enthalten, das heisst,

$$\frac{X_{ij}}{X_{hj}} = \frac{X_{ik}}{X_{hk}},$$

so ist bei jedem i und h Zero, $C_{j,k} = 0$.

Es zeigt sich ein maximaler Unterschied unter den Organen, $C_{j,k} = \sqrt{2}$, wenn für jeden i folgendes gültig ist:

wenn $X_{ij} > 0$, dann ist $X_{ik} = 0$
wenn $X_{ik} > 0$, dann ist $X_{ij} = 0$.

Unter den examinierten Teilen haben wir — $E_{j,k}$ und $C_{j,k}$ paarweise feststellend — cluster-Analyse durchgeführt.

Die gewonnenen Ergebnisse können in eine Matrix zusammengefasst werden und diese bildet den Ausgangspunkt zur cluster-Analyse. Von mehreren Verfahren scheint in diesem Fall die einfachste Methode, undzwar die Methode für »average linkage clustering« ausreichend zweckmässig und entsprechend zu sein (die Beschreibung der Methode wird unterlassen, s. z.B. SOKAL—SNEATH 1963, ORLÓCI 1975). Das Ergebnis der cluster-Analyse ist an einem Dendrogramm veranschaulicht. Das Dendrogramm kann in einem Koordinatensystem dargestellt werden, wo auf der horizontalen Achse die einzelnen Schilfrohrteile, auf der vertikalen dagegen das Mass der Distanz — bzw. in verkehrtem Verhältnis zu dieser — das Mass der Ähnlichkeit angegeben wird.

Tabelle 2

Vergleichungstabelle der Mittelwerte des Gehalts an biogenen Elementen der verschiedenen Teile des Schilfrohrs (Phragmites communis) (Daten aus 1976)

Schilfrohrorgane	Biogene Elemente	Mittelwert (n=11) bezogen auf die Trockensubstanz	Halm	Rhizom	Wurzel	Wurzelhaar (Adventiv-wurzel)
Blatt	N %	2,42	+	+	+	+
	P %	0 15	+	+	NS	NS
	Ca %	0,19	NS	NS	+	+
	Mg %	0,20	+	+	+	+
	K %	1,22	NS	NS	+	NS
	Na %	0,04	NS	NS	+	+
	Mn ppm	125,00	NS	NS	+	+
	Zn ppm	20,00	NS	NS	+	+
	Fe ppm	129,00	NS	NS	+	+
	Pb ppm	3,00	NS	NS	NS	+
	Sr ppm	13,00	NS	NS	+	+
	Cu ppm	3,00	NS	NS	+	+
Halm	N %	0,74	—	NS	NS	+
	P %	0,08	—	NS	NS	+
	Ca %	0,08	—	NS	+	+
	Mg %	0,06	—	NS	+	+
	K %	1,16	—	NS	NS	NS
	Na %	0,06	—	NS	NS	+
	Mn ppm	61,00	—	NS	+	+
	Zn ppm	14,00	—	NS	+	+
	Fe ppm	88,00	—	NS	+	+
	Pb ppm	1,00	—	NS	NS	+
	Sr ppm	1,00	—	NS	+	+
	Cu ppm	3,00	—	NS	+	+
Rhizom	N %	0,59	—	—	+	+
	P %	0,08	—	—	NS	+
	Ca %	0,35	—	—	+	+
	Mg %	0,12	—	—	+	+
	K %	1,24	—	—	+	NS
	Na %	0,11	—	—	NS	+
	Mn ppm	52,63	—	—	+	+
	Zn ppm	20,72	—	—	+	+

Fortsetzung Tabelle 2

Schilfrohrorgane	Biogene Elemente	Mittelwert (n=11) bezogen auf die Trockensubstanz	Halm	Rhizom	Wurzel	Wurzelhaar (Adventiv-wurzel)
	Fe ppm	545,18	—	—	+	+
	Pb ppm	2,54	—	—	NS	+
	Sr ppm	7,63	—	—	+	+
	Cu ppm	3,72	—	—	+	+
Wurzel	N %	0,86	—	—	—	NS
	P %	0,10	—	—	—	NS
	Ca %	1,34	—	—	—	+
	Mg %	0,30	—	—	—	NS
	K %	0,63	—	—	—	NS
	Na %	0,24	—	—	—	NS
	Mn ppm	278,00	—	—	—	+
	Zn ppm	112,00	—	—	—	NS
	Fe ppm	4903,00	—	—	—	+
	Pb ppm	14,00	—	—	—	NS
	Sr ppm	37,00	—	—	—	+
	Cu ppm	21,00	—	—	—	+
Wurzelhaar	N %	1,09	—	—	—	—
	P %	0,14	—	—	—	—
	Ca %	2,05	—	—	—	—
	Mg %	0,30	—	—	—	—
	K %	0,95	—	—	—	—
	Na %	0,32	—	—	—	—
	Mn ppm	433,00	—	—	—	—
	Zn ppm	136,00	—	—	—	—
	Fe ppm	6434,00	—	—	—	—
	Pb ppm	25,00	—	—	—	—
	Sr ppm	63,00	—	—	—	—
	Cu ppm	28,00	—	—	—	—

\+ = es besteht eine signifikante Differenz auf dem Wahrscheinlichkeitsniveau von $P = 5\%$

NS = es besteht keine signifikante Differenz auf dem Wahrscheinlichkeitsniveau von $P = 5\%$

Untersuchungsergebnisse

Die verschiedenen Teile des Schilfrohrs enthalten — im Durchschnitt von 2 Jahren — Poly- und Oligoelemente in folgender Quantität (im Prozentwert der Trockensubstanz, bzw. in ppm):

	N, P, Ca, K, Mg, Na, Fe %	Mn, Zn, Sr, Cu, Pb, ppm
Blatt	4.79	186
Halm	2.11	81
Rhizom	2.38	83
Wurzel	3.48	273
Wurzelhaar (Adventivwurzel)	4.78	637

Die untersuchten biogenen Elemente häuften sich in grösster Menge in den Blättern und Wurzelhaaren, sowie in den Wurzeln an. Die erwähnten Organe stellen die aktiviste Teile der Pflanzen dar — und zwar wegen ihrer Nährstoffaufnahme, bzw. ihrer Assimilationsfähigkeit. Die untersuchten Spurenelemente werden besonders von den Wurzelhaaren akkumuliert. Die Elementenanhäufung im Halm und Rhizom zeigt annähernd identische Mengen. Stickstoff und Phosphor, die unseren jetzigen Kentnissen gemäss eine wichtige Rolle in der Eutrophierung (Nährstoffanreicherung) des Sees spielen, akkumulieren sich vor allem in den Blättern des Schilfrohrs.

In der Umgebung der Zala-Mündung (Balatonberény, Balatonszentgyörgy, Fenékpuszta), wo — dank des Zala-Flusses — das Wasser des Balaton regelmässig mit einer grösseren Menge von Stickstoff (Phosphor und organischem Material) belastet wird, erreichte der Stickstoffgehalt der Blätter — laut den Untersuchungen in 1975 — 3,51—3,87 Prozent. Wo das Wasser des Sees weniger Stickstoff enthält (Balatonszepezd, Révfülöp, Balatonkenese) bewegte sich der Stickstoffgehalt um 2% herum.

Wo das Wasser und das Sediment einen höheren Phosphorgehalt zeigte (z.B. in der Umgebung der Zala-Mündung), konnte in den Schilfrohrblättern 0,15—0,19%, anderswo dagegen nur 0,07—0,14 Prozent gemessen werden.

Das Schilfrohr mag — von dem Stickstoff- und Phosphorgehalt der geochemischen Umgebung abhängend — beide Elemente in einer verhältnismässig grösseren Menge anhäufen. Aufgrund des Stickstoff- und Phosphorgehalts der Blätter kann man auch auf die Nährstoffverhältnisse des Wassers und des Sediments schliessen (vgl. Tóth—Szabó, 1968).

Im Halm, Rhizom und in der Wurzel häufen sich Stickstoff und Phosphor in verhältnismässig kleineren Quantitäten an. Die grosse Absorptionsfläche zeigende Wurzelhaar enthält ung. 1% Stickstoff und 0,12% Phosphor. Auf-

grund der im Ausland durchgeführten Produktionsuntersuchungen (vgl. DYKYJOVA—HRADECKÁ, 1976) kommen auf eine Raumeinheit ungefähr. 1 Gewichtsteil Blatt und 3 Gewichtsteile Halm vor. So häuft sich in 3 Gewichtsteilen des Halms und in einem Gewichtsteil des Blattes eine annähernd identische Menge von Stickstoff und Phosphor an.

Das Schilfrohrblatt und der Rohrhalm reservieren während der Vegetationsperiode eine bestimmte Menge biogener Elemente und diese Nährstoffmenge bleibt — als eine potentielle Belastung des Seewassers — aufrechterhalten. Auch darum ist es wichtig, dass — im Rahmen der planmässigen Schilfrohrbewirtschaftung — die absterbenden Blatt- und Halmteile, in der Winterperiode, aus der Uferzone weggeschaffen werden (Schilfrohrschnitt).

Von den Alkalimetallen kommt Kalium in grösseren Quantitäten im Blatt (1,13—1,22%)*, im Halm (0,89—1,16% und im Rhizom (0,95—1,24%) vor. Die Wurzel und die Wurzelhaare (Adventivwurzeln) enthalten eine verhältnismässig kleinere Quantität (0,44—0,95) von Kalium. Demgegenüber ist Natrium vor allem in der Wurzel (0,19—0,24%) und in den Wurzelhaaren (Adventivwurzeln) (0,14—0,32%) zu finden. Das Rhizom, der Halm und das Blatt enthalten nur wenig Natrium.

Kalzium und Magnesium sind in bedeutenderer Quantität besonders in der Wurzel (Ca 0,75—1,34%; Mg 0,47—0,30%) und in den Wurzelhaaren — Adventivwurzeln — (Ca 1,39—2,05%; Mg 0,45—0,30%) nachzuweisen. Kalzium kommt immer in einer grösseren Menge als Mg vor. Laut den Untersuchungen im Raume von Szigliget, Keszthely und Tihany (ENTZ—PÓNYI—TAMÁS, 1963) enthält das Sediment durchschnittlich 20 Prozent Ca (Mittelwert von 17 Proben) und 3,2 Prozent Mg (Mittelwert von 12 Proben).

Das relative Maximum von Eisen — welches einen Übergang zwischen Poly- und Oligoelementen darstellt —, Mangan, Zink, Blei, Stronzium und Kupfer zeigt sich in der Wurzel und in den Wurzelhaaren, eine Schwermetall-Akkumulation in kleinerem Masse kann jedoch auch im Blatt nachgewiesen werden.

Mit Berücksichtigung der absoluten Mengen der Elemente haben wir die Schilfrohrorgane auch aufgrund der Daten von 1975—1976 verglichen. Die Struktur der mittels einer cluster-Analyse gewonnenen Dendrogramme (Abb. 1a—1b) ist völlig identisch. Es ist wohl zu sehen, dass der Halm und das Rhizom am ähnlichsten sind, während sich auch zwischen den Wurzelhaaren und der Wurzel eine grosse Ähnlichkeit zeigt. Die im Blatt befindlichen Stoffmengen weichen von denen der übrigen Organe auffallend ab. Dem scheint zu widersprechen, dass z.B. aufgrund der Daten von 1976, zwischen dem Blatt und dem Halm, bzw. zwischen dem Blatt und dem Rhizom nur im Falle von 3

* Bei der Angabe der Mittelwerte bedeutet die erste Zahl den Wert der Analyse in 1975, die zweite den der Analyse in 1976.

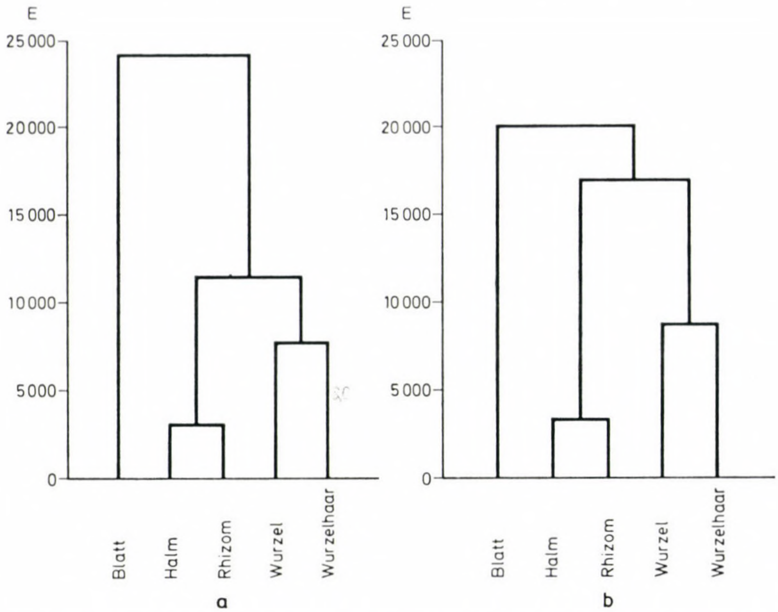

Abb. 1. Dendrogramm der Schilfrohrorgane aufgrund der Distanzfunktion von EUKLID. a: 1975, b: 1976

Elementen eine signifikante Differenz nachzuweisen war (N, P, Mg). Diese Elemente häufen sich jedoch — im Vergleich mit dem Halm und Rhizom — im Blatt in grosser Quantität an.

Die Untersuchung der Proportionen der Elemente führte zu den Dendrogrammen, die auf Abbild 2a—2b dargestellt wurden. Der Halm und das Rhizom, bzw. die Wurzel und die Wurzelhaare zeigten auch in dieser Hinsicht eine grosse Ähnlichkeit. Das Blatt weicht auch in diesem Fall bedeutend ab, so kann z.B. aufgrund der Daten von 1976 festgestellt werden, dass sich die Proportionen der Elemente aufgrund der chord-distance in der Richtung Wurzelhaar—Wurzel—Rhizom—Halm—Blatt verschieben:

Blatt-Halm	= 0,528
Blatt-Rhizom	= 0,661
Blatt-Wurzel	= 0,849
Blatt-Wurzelhaar	= 0,897

Von den Teilen des Schilfrohrs zeigt das Rhizom die längste Lebensdauer (vgl. RODEWALD—RUDESCU, 1974), es bewahrt seine Aktivität für 3—10, in manchen Fällen sogar für 20 Jahre. So werden die im Rhizom befindlichen Elemente für eine längere Zeit reserviert.

Infolge der Akkumulation von Schwermetallen in der Wurzel und in den Wurzelhaaren des Schilfrohrs wird die toxische Wirkung dieser Metalle

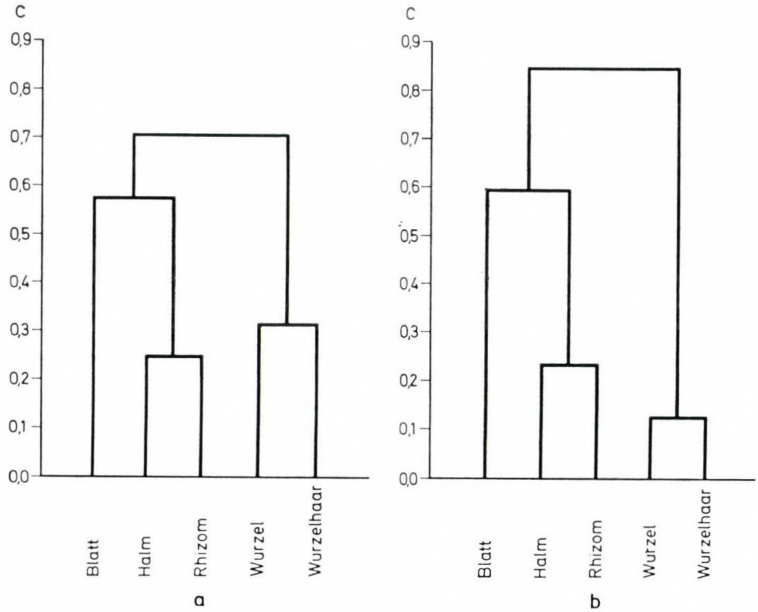

Abb. 2. Dendrogramm der Schilfrohrorgane aufgrund der chord-distance. a: 1975, b: 1976

geschwächt. Das ist besonders wichtig im Falle von Zn und Cu. Beide Schwermetalle können mit den Fungiziden »Zineb« und »Cupromix«, die bei der Berieselung (vom Flugzeug) der Weingebiete der Balaton-Gegend angewandt werden, in den See gelangen. Laut der Untersuchung des VITUKI* in 1973 (VITUKI, 1975) enthält das Wasser des Balaton 10—50 Milligramm/l Zink und 2—8 Milligramm/l Kupfer. Laut den Untersuchungen von Herbst (1966) übt bereits eine kleine Menge Zink eine toxische Wirkung auf die verschiedenen Gammarus-Arten aus.

Den literarischen Daten gemäss (Hürlimann, 1961, Krotkevic, 1963, Nikolajevskij, 1970, Rodewald-Rudescu, 1974, Dykyjova—Hradecká, 1976, usw.) besitzt die Adventivwurzel des Schilfrohrs die Fähigkeit, Nährstoffe auch unmittelbar aus dem Wasser aufzunehmen. Das ist darum bedeutend, weil die in das Wasser gekommenen Nährstoffe und Schwermetalle im Schilfrohr beinahe sofort blockiert werden können.

Aufgrund der Berechnung des Konzentrationsfaktors (die hinsichtlich der chemischen Zusammensetzung des Balaton-Wassers vorgenommen wurde) konnte festgestellt werden, dass die Wurzelhaare, bzw. die flaumhaarigen Adventivwurzeln die untersuchten biogenen Elemente (Schwermetalle) aus ihrer Umgebung in bedeutender Quantität anzuhäufen vermögen. Zum Ver-

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gleich wird hier auch der Konzentrationsfaktor* der Balatoner Laichkräuter angegeben (vgl. KOVÁCS, 1977).

Konzentrationsfaktor der Elemente:

	Schilfrohr Wurzelhaar, Adventivwurzel	Laichkräuter
N	10^4	10^4
Fe	10^4	10^3
Mn	10^4	10^3-10^4
K	10^3	10^3
Cu	10^3	10^3
Zn	10^3	10^3
P	10^2	10^5
Ca	10^2	—
Mg	10^2	10^2
Na	10^2	10^2

Aufgrund der Daten des Konzentrationsfaktors vermögen die flaumhaarige Adventivwurzel und das Wurzelhaar des Schilfrohrs — infolge ihrer grossen Adsorptionsfläche — eine ebenso grosse Menge von Stickstoff und Schwermetallen zu akkumulieren, wie die Laichkrautarten. Phosphor wird in den Wurzelhaaren in einer verhältnismässig kleineren Quantität angehäuft als in den Laichkräutern, das wird aber von der grösseren Schilfrohrmasse ausgeglichen. Es ist charakteristisch für das typische Röhricht, dass in seiner unteren Schicht häufig Laichkräuter zu finden sind, die den in das Wasser gekommenen Phosphor festbinden. So spielt im Schutz des Sees, in der biologischen Reinigung des Wassers und in der Blockierung des ins Wasser gelangten Phosphors nicht allein das Schilfrohr, sondern das gesamte Röhricht eine bedeutende Rolle.

Die verschiedenen Organe des Schilfrohrs häufen die untersuchten Elemente — aufgrund der quantitativen Verhältnisse — in verschiedenen Mengen an, während diese Reihenfolge gelichzeitig auch für die verschiedenen Organe charakteristisch ist:

Blatt:	N > K > Mg > Ca > P > Na > Fe > Mn > Zn > Sr > Cu > Pb
Halm:	K > N > Mg > Ca > P > Na > Fe > Mn > Zn > Cu > Pb > Sr
Rhizom:	K > N > Ca > Mg > Na > P > Fe > Mn > Zn > Sr > Cu > Pb
Wurzel:	Ca > N > K > Mg > Fe > Na > P > Mn > Zn > Sr > Cu > Pb
Wurzelhaar: (Adventivwurzel)	Ca > N > K > Mg > Fe > Na > P > Mn > Zn > Sr > Cu > Pb

* Konzentrationsfaktor =

$$= \frac{\text{Quantität des Elements, bezogen aus den Trockengewicht der Pflanze in ppm}}{\text{Gehalt des Wassers an Elementen in } \mu\text{g/ml}}$$

Zusammenfassung der Untersuchungsergebnisse

Das Schilfrohr akkumuliert aus seiner Umgebung eine bedeutende Menge biogener Elemente in seinem Organismus an, schliesst diese für eine bestimmte Zeit aus dem biochemischen Zyklus aus und macht sie für andere Pflanzen (Laichkraut, Alge) unaufnehmbar.

Die verschiedenen Organe des Schilfrohrs enthalten die biogenen Elemente in differenten Quantitäten und aufgrund der quantitativen Verhältnisse in abweichender Reihenfolge.

Das Schilfrohr häuft die biogenen Elemente in seinen Blättern an, vor allem N, P und K, die in der Nährstoffanreicherung des Seewassers eine Rolle spielen. Da das Schilfrohr eine grössere Menge von Stickstoff und Phosphor aufzunehmen vermag, ist sein Schutz an solchen Stellen erwünscht, und es besitzt in Hinsicht auf den Umweltschutz des Sees besonders dort eine Bedeutung, wo die einmündenden Gewässer das Wasser des Balaton mit einer grossen Menge organischer und Nährstoffe belasten (z.B. in der Nähe von landwirtschaftlichen Kulturen, usw.).

Aufgrund des N- und P-Gehalts der Blätter kann auf den geochemischen Charakter des Biotops und auf die Nährstoffverhältnisse des Wassers, sowie des Sediments geschlossen werden.

Da das Schilfrohr die biogenen Elemente vor allem in seinen Blättern anhäuft und der Abbau der Elemente schnell vor sich geht, ist es notwendig, dass in der Herbst- und Winterperiode die absterbenden Blatt- und Halmteile regelmässig weggeschaffen werden.

Infolge der grossen Adsorptionsfähigkeit der Wurzel, und besonders des Wurzelhaars (Adventivwurzel) enthalten diese Organe eine bedeutende Menge biogener Elemente. Ca ist vor allem in der flaumhaarigen Belegung zu messen, wo sich fallweise auch Mg und das relative Maximum des Na-Gehalts befindet. Von den untersuchten Mikroelementen häuft sich hier Mn, Zn, Fe, Sr, Pb und Cu an. Das Wurzelhaar, bzw. die Adventivwurzel verringern durch die Akkumulation von Schwermetallen die Toxizität der in das Wasser gekommenen Schwermetalle.

LITERATUR

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STUDIES ON AFRICAN CALYMPERACEAE II

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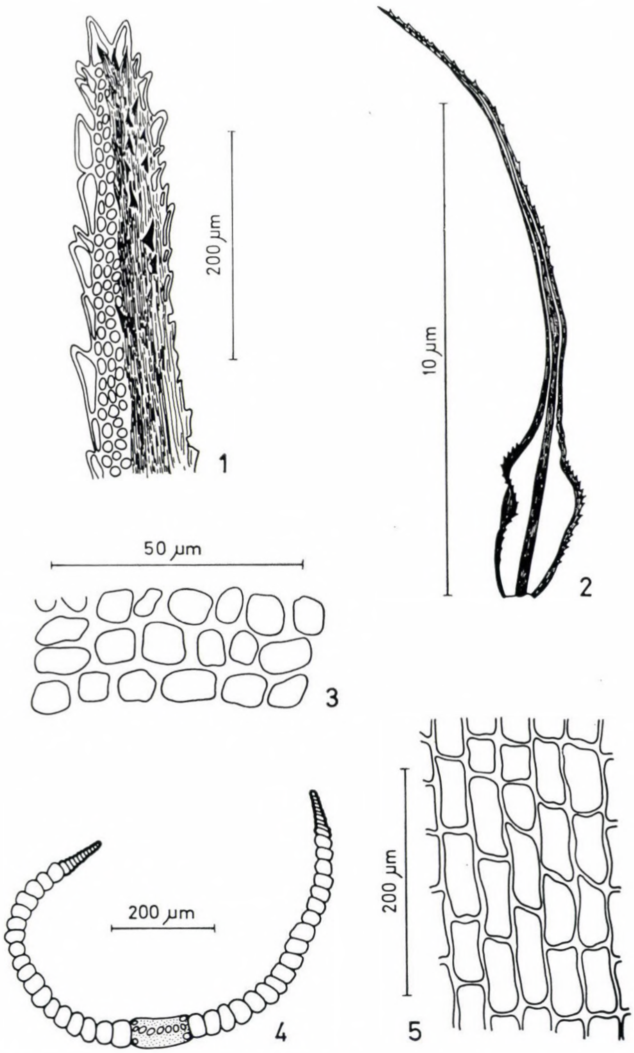
Syrrhopodon usambaricus Broth. ex Orbán spec. nov. Occurrence of *S. brevivaginans* Demar. et Leroy and of *S. linealis* Dix. et Thér. in East Africa, of *S. mauritianus* in East Africa and in Madagascar. *Syrrhopodon glaucovirens* Mitt. var. *rufus* Ren. er Gard. nom. nud. is a synonym of *S. glaucophyllus* Ren. et Card. var. *rufus* Ren. et Card.

Studying the African *Syrrhopodon* materials of the Helsinki National Museum (H, consisting mostly of the materials of BROTHERUS Herbarium, H-BR), the author has found, along several interesting data, an undescribed East African species, designated on the herbarium label by BROTHERUS, as *Syrrhopodon usambaricus* sp. nov. The author, comparing this specimen with other East African materials, recognized it, as new, composed its diagnosis and completed the knowledge about its distribution by data from the Uluguru Mountains.

1. Syrrhopodon usambaricus Broth. ex Orbán nov. spec.

(Subgenus Orthotheca) Figs 1—12

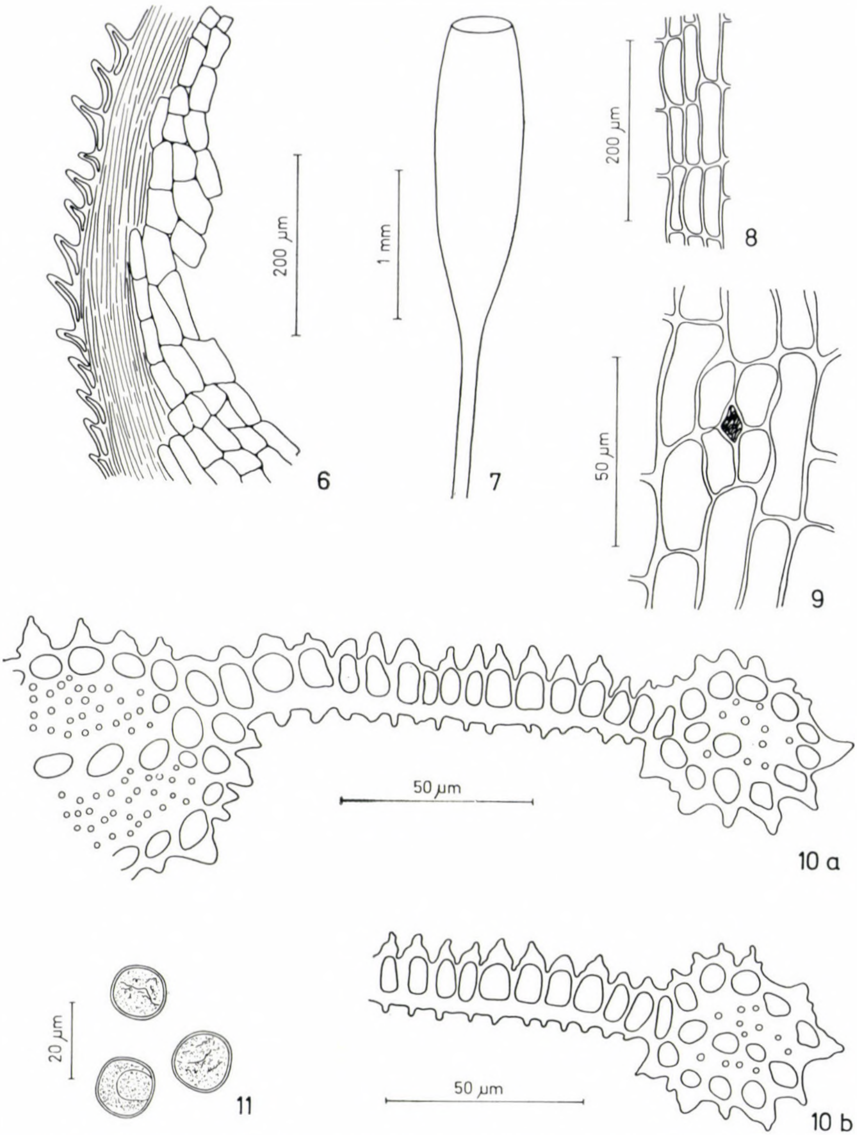
Diagnosis: Habitu *Syrrhopodon stuhlmannii* simile. Laxe caespitosus, pallide vel alboviridis. Caulis ramosus, 2—10 cm longus, apice radiculosus, ob vaginam folii albicans, dense vel laxe foliosus. Folia sicca erecto-arcuata, madida erecto-patentia, apice longe acuminata, lineari-lanceolata, 8—12 mm longa. Vagina obovata, 1/4—1/5 folii longitudinis attingens, ventre, 1,5—2 mm lata, basi 1 mm. Cellulae limbidii vaginae 8—11 seriatae, unistratae; margines vaginae versus basim sensim evanescentes, ciliis arcuatis ornati. Cellulae cancellinarum ad ventrem 15—18 seriatae, rectangulae, 29—57 μm, versus limbum quadratae vel subquadratae, supra ventrem vaginae in lamina ad 1/3 folii longitudinis continuae. Lamina e parte vaginae sensim angustiora, limbo laminae pluristrato, 50 μm lato, e medio parte folii geminatim serrato et supra ventrem ad apicem acutis papilloso. Cellulae chlorophyllosae laminae rectangulae vel hexagonae, 6,3 $\times$ 8,5 μm, irregulares, magnae et acute papillosae. Costa basi 90—100 μm lata, apicem versus 70 μm, dorso aculeato papillosa, superne utrinque dentata. Dioicus. Folia perichaetialia caulinis similia. Capsula oblonga ovata, subcylindrica, 2 mm longa, pedicello fulvo, 0,7—1 cm longo.



Figs 1—5. Syrrhopodon usambaricus Broth. ex Orbán n. sp. 1. leaf apex; 2. leaf; 3. chlorocysts; 4. transversal section of leaf sheath; 5. cancellinae. All drawn from the type (H-BR)

Holotypus: Usambara, Lutindi, leg. Liebusch 1902 (H-BR).

In appearance similar to *Syrrhopodon stuhlmannii* Broth., forming dull, pale green cushions of 2—10 cm height. Stem branching, covered by rhizoids in its full length, and by whitish leaf sheaths. Leaf blades bent and declining from the stem, when dry, moistened stiff and spreading, lanceolate, 8—12 mm long, gradually pointed. Sheathing part obovate, 1/4—1/5 of the full leaf length, widest at its upper third (1.5—2.0 mm, while at its base only 1 mm broad), bordered by 8—11 cells of broad, unistratose limbidium, with dentate margin;



Figs 6—11. Syrrhopodon usambaricus Broth. ex Orbán n. sp. 6. ciliate border of sheath; 7. capsule; 8. exothecial cells; 9. stoma of capsule neck; 10. a) and b) transversal sections from the middle part of blade; 11. sporae. 6. and 10a), b) are drawn from the type (H-BR), 7.—9. and 11. are drawn from T. Pócs, J. and M. Kornaś No 6531/H. (EGR)

teeth large and turned outwards on the shoulder, shorter and finally disappearing towards the base. Cacellinae in 15—18 rows at the broadest part, elongate quadrangular, 29×57 μm in the center, almost square near the border, of sheath; continuing in the blade along the midrib, up to about 1/3 of full leaf length.

The lamina above the sheathing part ("blade" in the future) narrow lanceolate, gradually tapering into a very long acumen, bordered by pluristratose margin. Hyaline border at mid-leaf length 50 μm broad, papillose, with double teeth becoming denser near apex. Conducting elements are seen along the stereids in its transversal section. The conducting elements gradually disappear towards apex. Chlorocysts small, rounded 4—6 angular, 6.3—8.5 μm, ornated by 1 large, apiculate papillae on each side. Midrib vigorous, width at base 90—100 μm, near apex 70 μm, dorsally spinose, ventrally, covered by blunt papillae.

Dioicous. Perichaetial leaves similar to those of the stem leaves. Seta 7—10 mm long, reddish yellow. Capsule oblong ovate, brownish red, there are phaneropor stomata with 4 guard cells on its neck.

Note: The above described species belong to the Subgenus *Orthotheca*, Section *Tricostatae* (proposed by S. ORBÁN). Although in its appearance resembles *S. stuhlmannii*, the other member of the same section, it differs from it in several important characters. First, the border of leaf sheath is unistratose by *S. usambaricus*, while *S. stuhlmannii* has a robust, midriblike sheath border with stereids and with central conducting elements. On the other hand, the border of the blade is similar to that of *S. stuhlmanii*, having the same stereid, and conducting elements, and differing in this way from all other African species of the genus. Other distinguishing characters of *S. usambaricus* are: the papillosity of chlorocysts on both sides of the blade, the shorter seta and the structure of stomata on the capsule neck, which have 4 guard cells (2 by *S. stuhlmannii*).

The structure of leaf border, similarly to *S. stuhlmannii*, has evolutionary significance. The new species connects *S. stuhlmannii* with the other species of Subgenus *Orthotheca*, which have a pluristratose border composed of stereids, but without conducting elements (cf. DEMARET—LERY 1947).

Ecology: *Syrrhopodon usambaricus* occurs in the Uluguru Mountains, similarly to *S. stuhlmannii* in mountain forests and in elfin woodlands, where the annual precipitations exceed 3000 mm on an average, and there is no dry season (PÓCS 1976), at an altitude of 1400—2100 m. It never occurs on soil (*S. stuhlmannii* is mostly terricolous), but only on granitic rocks and more seldom, on bark.

Seems to be endemic in the old, mostly precambrian crystalline massifs of Tanzania, East Africa, as in the Ulugurus and in the Usambara Mountains.

Distribution:

Usambara Mts.
— Lutindi, leg. LIEBUSCH, 1911. — (H—BR). (Sub nomine *Syrrhopodon Liebuschii* Broth. nom. nud. ex H-BR.)

Uluguru Mts.
— South end of Lupanga. Ridge above village Mbete, 1850—2000 m, Elfin forest of *Podocarpus*, *Syzygium*, *Schefflera polysciadia*, *Allanbackia uluguruensis*. On shady

granitic rocks. Coll.: T. Pócs and K. B. G. Nchimbi, 6287/C. (Sub nomine *S. mildbraedii* Broth. in Bizot and Pócs 1974; 421). (EGR, BP, DSM)
— In the lower part of Mwere valley above Morogoro, in 1450—1530 m alt. Mountain rain forest along Mwere stream. On shady rocks. Coll.: T. Pócs, J. and M. Kornaś 6531/H. (EGR, BP, DSM)
— SE ridge between Bondwa and Magari, 2000—2100 m. Corticolous in elfin forest. Coll.: T. Pócs, R. Faden, B. Harris, P. and K. Csontos, 6261/R. (EGR, BP, DSM)
— Gorge of Mt. Kinazi near the waterfall in alt. 1400—1650 m, above Morogoro. Mountain rain forest, rocky type. Corticolous. Coll.: T. Pócs, 6289/BG. (EGR, BP)
— On the vertical granitic rock walls of Magari Peak above Mzinga, 2150 m alt. Coll.: T. Pócs, Kondela and Nchimbi, 6298/O. (EGR, BP)

2. Some interesting occurrences in East Africa and in the neighbouring Islands

Syrrhopodon brevivaginans Demar. et *Leroy in East Africa*

The species, described by Demaret and Leroy (1974: 224) from Central Africa, from the eastern highlands of Zaire, is now recognized from two localities in Tanzania, both occurring in the submountain rain forest zone, with high (2—3000 mm) precipitation and no real dry season. The occurrence on bark in the highly precipitous areas is similar to the type locality.

It is worth mentioning, that Brotherus has found and recognized this species, as new, from the collection of Baur made in the Usambara Mountains at the beginning of this century. He wrote the name *Syrrhopodon* (*Orthotheca*) *grandidens* Broth. on the herbarium label, but never described it. Demaret and Leroy have not seen this specimen, therefore this early record came to light only, when the present author studied the materials from the Brotherus herbarium and found it to be conspecific with *S. brevivaginans.*

Distribution:

Type locality: Kafukumba, leg. F. Overlaet, Nov. 1922. riv. Lushiji, cours inférieur, corticole, leg. Overlaet 1923.

New records:

Usambara Mts.
— Inter Magrotto et Muheza, in truco permagno a rento dejecto, 690 m, 1906, coll.: G. Baur, Bryoth. E. Levier No 6792. (sub nomine *Syrrhopodon* [*Orthotheca*] *grandidens* Broth. nom. nud. ex Herb. V. F. Brotherus). (H-BR)

Uluguru Mts.
— Submountain rain forest near Kinole sawmill, 1000 m. Corticolous, Coll.: Pócs, Faden, Csontos, Harris, 6264/N. (EGR)

Syrrhopodon mauritianus C. Müll. ex Ångstr. new for continental Africa and for Madagascar

Syn.: *S. malouinensis* Ångstr.

Syn. nov.: *S. sparsus* Ren. et Card.

This species was known until now only from the Mascarene Islands (Mauritius, Réunion). The author has identified it from the materials collected

by T. Pócs in the Uluguru Mts., Tanzania, which agrees well with the authentic specimens of *S. mauritianus*. After studying the description and materials of the related *S. sparsus* Ren. et Card., the author has found a Madagascar specimen from the BROTHERUS Herbarium (H-BR), which was studied and designated by RENAULD and CARDOT, to the latter species. Already RENAULD and CARDOT observed the close relation between the two species, basing their distinction only on "petites dimensions, la forme des feuilles et le tissu de la base l'en éloignent considerablement" by *S. sparsus*. Comparing the transversal section of this Madagascan *S. sparsus* specimen with the figures of the type of *S. mauritianus* given by DEMARET et LEROY (1974: 214, fig. 27/C), and with other *S. mauritianus* specimens, their structure proved to be identical. Only the size of the plants and the shape of their leaves seemed to be slightly different. But, when the present author studied the juvenile shoots of *S. mauritianus*, found a complete identity with the Madagascan *S. sparsus* specimen and with the descriptions of *S. sparsus* by RENAULD and CARDOT. Therefore on the one hand, this specimen from Madagascar should be identified with *S. mauritianus*. On the other hand, *S. sparsus* Ren. et Card. is also a juvenile form of *S. mauritianus* — as it was proved after examining the type specimen of *Syrrhopodon sparsus*.

The occurrence of *Syrrhopodon mauritianus* in Madagascar and in East Africa enriched known number of the Madagascan elements in the old crystalline massifs of East Africa, studied by Pócs (1975), underlining the close floristic affinity of these mountains not only with Madagascar, but also with the Mascarene Islands, similarly to the distribution of the recently described *Syrrhopodon insularis* Bizot et Onraedt (cf. ORBÁN 1978).

Distribution:

Réunion, leg. RODRIGUEZ, ex Herb. J. CARDOT (H-BR)
Mauritius, leg. VOELTZKOW, 1904, (H-BR)
Mauritius, leg. N. J. ANDERSSON, 1872, (Cit. BESCHERELLE) 1878: 349 (PC)
Mauritius, leg. JITADORROU (Sub nomine *S. malouinensis* (H-BR)
Madagascar, Reg. australe: cercle militaire de Bara, secteur d'Ivondro, poste de Soarano, leg. CROLL, 1900, ex Herb. G. Paris (H-BR) — sub nomine *S. sparsus* Ren. et Card.
Tanzania, Uluguru Mts., Mwere valley above Morogoro, 1450 m, Wet mountain forest near the stream. On bark. leg T. Pócs 6105/AG. (EGR, BP)

Syrrhopodon linealis Dix. et Thér. in East Africa

This member of the Section *Crispati* was known only from the fringing forests and from the surrounding deciduous woodlands of upper Shaba, Zaire. The new record from the Ulugurus, Tanzania, agrees quite well with these in its environmental features, from the border of deciduous woodland and

mountain forest zones on the lower rainfall lee-side of the mountains. The new localities:

Tanzania, Nguru Mts. Mafulumula coll. above Mnembula village in 1650—1800 m. Mountain rain forest. Corticolous. Coll.: T. Pócs and H. J. Schlieben No 6438/AF (EGR, BP)
Tanzania, Uluguru Mts. On the W-ridge of Lupanga peak above Morogoro Town. In woodland-forest transition, 1350—1500 m. Corticolous. Coll.: T. Pócs, R. and S. Sharma, P. Mwanjabe, 6546/H. (EGR)

Syrrhopodon glaucophyllus Ren. et Card. var. rufus Ren. et Card., Bull. Soc. R. Bot. Belg. 33/2: 116 (1895)

Syn.: *Syrrhopodon rufus* Ren. et Card. nom. nud., Musci Masc. Mad. Exsicc. no. 114.

Syn. nov.: *Syrrhopodon glaucovirens* Mitt. var. *rufus* Ren. et Card. ex Wijk-Margadant-Florschütz: Index Muscorum 4: 604 (1968).

The latest combination is an error in the IVth volume of Index Muscorum, referring by the name of *Syrrhopodon rufus* to the combination of *S. glaucovirens* Mitt. var. *rufus* Renauld et Cardot (1895: 116). In fact, the French authors in the cited paper proposed validly the combination of *S. glaucophyllus* var. *rufus*, and used neither here, nor in their later works the combination given by the Index. *Syrrhopodon glaucovirens* Mitt. belongs to an other subgenus (*Orthotheca*), and not to *Eusyrrhopodon*, where *Syrrhopodon glaucophyllus* and its variety rufus does. An original specimen of *S. rufus* Ren. et Card. deposited in H-BR was studied by the author, who compared it with the types of both *S. glaucophyllus* and *S. glaucovirens*. The specimen showed affinity only with the former species.

In the Vth volume of Index Muscorum (1969) the Supplementum cites properly the name of the combination *Syrrhopodon glaucophyllus* Ren. et Card. var. *rufus* Ren. et Card., but fails to make the necessary correction of the mistake made in Vol. IV and gives a wrong pagination for the paper of Renauld and Cardot (117 instead of 116). Therefore the Index does not exclude the possibility of two independent taxa, which in reality do not exist.

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A METHOD FOR CLUSTERING OF BINARY (FLORISTICAL) DATA IN VEGETATION RESEARCH

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A new formula, weighted dissimilarity index (WDI) is proposed for measuring local and floral dissimilarity taking the importance of attributes into consideration. Application of this index to the "centroid sorting" method is illustrated by a hypothetical example. Results of the study of a rocky grassland community are also included and briefly discussed.

I. Introduction

I.1. It is well-known that the use of binary (presence-absence) data has many advantages in vegetation analysis but in most papers published until now the problem of weighting has generally been neglected. In the comparison of two quadrats all species were taken into consideration of equal weight. It is obvious, however, that some "mass variables" (e.g. frequency) should have some rôles in constructing a sorting algorithm. In this case the more frequent species are more important than the less frequent or rare ones, so the common species should have greater effect on the similarity (or dissimilarity) between two given quadrats. In the same way, in consequence of the duality of attributes, the quadrats of highest species number give the greatest information about some plausible measure of dependence, so they should be considered with a higher weight than the quadrats of small number of species.

Starting from the assumptions mentioned above, I propose a weighted dissimilarity index (denoted by WDI in this paper). The application of WDI seems to have many advantages for cluster analysis, and so it is worth demonstrating by both hypothetical and concrete examples (V—VI).

I.2. The indices and metrics used in vegetation research will not be detailed here. Advantages and disadvantages of these functions have been discussed by numerous papers and monographs (DAGNÉLIE 1960; SOKAL and SNEATH 1963; GREIG-SMITH 1964; KERSHAW 1964; CHEETHAM and HAZEL 1969; GOUNOT 1969; GOODALL 1973a; ORLÓCI 1972, 1975 etc.). In this paper only the most important formulae will be mentioned (III.). The methodical problems

of cluster analyses will not be discussed, either, since numerous books and articles are available concerning this topic (LANCE and WILLIAMS 1966; WILLIAMS, LAMBERT and LANCE 1966; ROHLF 1970; JARDINE and SIBSON 1971; ORLÓCI 1975; HARTIGAN 1975).

I.3. The method described in IV.—V. can also be applied to quantitative data (coverage, frequency etc.), but in this study only the binary cases are dealt with. Comparison of quantitative data raises a number of questions the discussion of which is beyond the scope of this paper.

II. Definitions

II.1. Before the discussion it is important to give a summary of the denotations and their definitions used in this paper. First let us consider the following matrix:

$$U^{(0)} = \begin{array}{c|ccc|} & t_1 & t_j & t_m \\ \hline s_1 & & \vdots & \\ s_i & \cdots & f_{ij}^{(0)} & \\ s_n & & & \\ \hline \end{array} \qquad v = \begin{bmatrix} v_1 \\ v_i \\ v_n \end{bmatrix} \qquad \hat{p} = \begin{bmatrix} \hat{p}_1 \\ \hat{p}_i \\ \hat{p}_n \end{bmatrix}$$

$$z = [z_1, \ldots z_j, \ldots z_m]$$
$$q = [q_1, \ldots q_j, \ldots q_m]$$

In matrix $U^{(0)}$ the columns are the floral vectors of the sampling units, the rows are the local vectors of the species. It is worth mentioning that $U^{(0)}$ may be called floristic composition which is a set of relations between m sampling units and n species found in the examined area T (JUHÁSZ-NAGY 1976).

II.2. $f_{ij}^{(0)}$ expresses the species-locus relation:

$$f_{ij}^{(0)} \begin{cases} 1, \text{ if } s_i \text{ is present in } t_j \\ 0, \text{ if } s_i \text{ is not present in } t_j, \end{cases}$$

so $f_{ij}^{(0)}$ is an indicator function. The $^{(0)}$ upper index indicates that $U^{(0)}$ is the matrix of the basic data. In the course of the clustering algorithm either the number of the columns or that of the rows of this matrix will be reduced step by step. Then $f_{ij}^{(x)}$ will no longer be an indicator function and its value will range from 0 to 1 (see V. for more details).

II.3. Let v_i denote the number of those sampling units in which s_i is present. Thus v is the valence distribution of all the species:

$$v = [v_1, \ldots v_i, \ldots v_n], \quad \text{where } v_i = \sum_j f_{ij}^{(0)} . \qquad \text{(II.3.1.)}$$

II.4. z_j is the number of species present in t_j. Accordingly z is the valence distribution of the sampling units:

$$z = [z_1, \ldots z_j, \ldots z_m], \quad \text{where } z_j = \sum_i f_{ij}^{(0)} \tag{II.4.1.}$$

II.5. N denotes the total valence:

$$N = \sum_i v_i = \sum_j z_j \tag{II.5.1.}$$

II.6. Let $\hat{p}_i$ denote the estimated probability of the presence of s_i in T at the given quadrat size. Thus $\hat{p}$ is the probability distribution of the species:

$$\hat{p} = [\hat{p}_1, \ldots \hat{p}_i, \ldots \hat{p}_n,], \quad \text{where } \hat{p}_i = \frac{v_i}{m} \tag{II.6.1.}$$

II.7. q_j denotes the proportion of the species present in t_j, to the species present in T. Thus q is the floral frequency distribution of the sampling units:

$$q = [q_1, \ldots q_j, \ldots q_m,], \quad \text{where } q_j = \frac{z_j}{n} \tag{II.7.1.}$$

II.8. The following relations are valid for p_i and q_j, respectively:

$$0 \leq \hat{p}_i \leq 1 \tag{II.8.1.}$$

$$0 \leq q_j \leq 1 \tag{II.8.2.}$$

$$\frac{v_i}{N} = \frac{\hat{p}_i}{\sum_i \hat{p}_i} \tag{II.8.3.}$$

$$\frac{z_j}{N} = \frac{q_j}{\sum_j q_j} \tag{II.8.4.}$$

II.9. Resemblance functions for binary data use the parameters of the $2 * 2$ contingency table. In case of a comparison of two quadrats the meanings of the parameters are the following:

(a) represents the number of common species in the two quadrats in question (t_j and t_k);

(b) is the number of species which occur in quadrat t_j, but not in t_k;

(c) indicates the number of species which occur in quadrat t_k, but not in quadrat t_j;

(d) is the number of species absent from quadrats t_j and t_k, but present in some other ones.

In calculating the correlation between two species these parameters should be used, of course, in the same way for the pairs of rows of $U^{(0)}$.

II.10. Let X_{ij} denote any quantitative feature (coverage, frequency etc.) of s_i in t_j.

III. Some important coefficients

III.1. Numerous indices for presence–absence data use only the data of the quadrats (or the species) concerned (a, b, c parameters). SØRENSEN index and JACCARD index are well-known examples.

III.2 Other formulae take not only the data of the two compared quadrats into consideration, but those of the rest, too (they are involved in the parameter *d*). In these cases the number of the joint presence and that of the joint absence has equal effect on resemblance. The most simple of them is the matching coefficient of SOKAL and MICHENER (1958):

$$E_{SM} = \frac{a+d}{a+b+c+d} \qquad \text{(III.2.1.)}$$

The product-moment correlation coefficient is also widely used:

$$E_{\Phi} = \frac{ad - bc}{\sqrt{(a+b)\,(a+c)\,(b+d)\,(c+d)}} \qquad \text{(III.2.2.)}$$

Owing to its disadvantages (EADES 1965, BARONI-URBANI and BUSER 1976) this coefficient is proposed for large samples. The formula of BARONI-URBANI and BUSER (1976) can be used for relatively small samples as well without much bias:

$$E_{BB} = \frac{\sqrt{ad} + a - b - c}{\sqrt{ad} + a + b + c} \qquad \text{(III.2.3.)}$$

III.3. The absolute value function that has been used for quantitative data only seems to be applicable to the comparison of sampling units:

$$E_{abs\,jk} = \sum_i |x_{ij} - x_{ik}| \;. \qquad \text{(III.3.1.)}$$

WHITTAKER (1952) used this formula in its relative form:

$$E_{W\,jk} = \sum_i \left| \frac{x_{ij}}{\sum_i x_{ij}} - \frac{x_{ik}}{\sum_i x_{ik}} \right| \qquad \text{(III.3.2.)}$$

The similarity between two quadrats is maximal ($E_W = 0$) if they both contain the same species and the proportion of the species in them is also equal.

The so-called "Canberra-metric" is also based on the absolute differences (LANCE and WILLIAMS 1966):

$$E_{LW\,jk} = \frac{\sum_i \frac{|x_{ij} - x_{ik}|}{x_{ij} + x_{ik}}}{n} \;. \qquad \text{(III.3.3.)}$$

The value of E_{LW} ranges from 0 to 1, 0 indicates the maximal similarity.

III.4. The coefficients mentioned in III.1.—3. make no distinction between the attributes. WILLIAMS—DALE—MACNAUGHTON-SMITH (1964) pointed out this insufficiency: "some attributes are more important than others in determining similarity". They proposed a weighted coefficient for quantitative data:

$$E_{WDM_{jk}} = \sum_i \left[(x_{ij} - x_{ik})^2 \cdot \sum_{h \neq i} \chi^2_{hi} \right], \qquad \text{(III.4.1.)}$$

where $\sum_{h \neq i} \chi^2$ is the sum of the χ^2 values calculated between s_i and the all other species. When χ^2 test is applied, however, the same difficulties will arise which appeared at the use of formula III.2.2.

IV. A new dissimilarity index and its properties

IV.1. In order to eliminate the insufficiences of coefficients having been used for binary cases until now, I propose a new formula, weighted dissimilarity index (WDI), for comparing sampling units defined as

$$d_{jk} = \frac{\sum_i \left(p_i \cdot |f_{ij}^{(0)} - f_{ik}^{(0)}|\right)}{\sum_i p_i} \qquad \text{(IV.1.1.)}$$

The value of d_{jk} depends on the distinctive species of quadrats t_j and t_k. The absolute values of the differences are weighted with the estimated probability of the presence of the species concerned, and then these products are added up. The upper limit of this sum i.e. the numerator of formula IV.1.1. is the quantity $\sum_i p_i$, which is the maximum possible dissimilarity between any two quadrats included in $U^{(0)}$. It is obvious that $\sum_i p_i$ is obtained as dissimilarity value if the two compared quadrats neither have joint absence nor joint presence at all. It is reasonable to standardize with the quantity $\sum_i p_i$, so the value of d_{jk} will range from 0 to 1. Since

$$\sum_i p_i = \sum_i \frac{v_i}{m} = \frac{N}{m}, \qquad \text{(IV.1.2.)}$$

the nominator of formula IV.1.1. indicates the average participation of a quadrat in the total valence, i.e. the average number of species in the quadrats.

It is to be noted that d_{jk} is not directly effected by the number of joint presence and joint absence, so the index IV.1.1. differs essentially from the formulae discussed in III.

IV.2. For measuring the dissimilarity between any pair of species I propose the formula defined as

$$d_{hi} = \frac{\sum_j (q_j \cdot |f_{hj}^{(0)} - f_{ij}^{(0)}|)}{\sum_j q_j} \qquad \text{(IV.2.1.)}$$

that is analogous to index IV.1.1. The dissimilarity between s_h and s_i depends on the number of species of those quadrats in which only one of the two species is present. Hereby the quadrats of a smaller number of species will have less effect on d_{hi} than the quadrats of a high number of species. It is worth to explain it with a simple example: a quadrat of 10 species contains less information about the interspecific correlations than a quadrat of 35 species, so we must consider the second quadrat with a greater weight.

The quantity of $\sum_j q_j$ signifies the average participation of a species in the total valence, i.e. the average number of presence of the species:

$$\sum_j q_j = \sum_j \frac{z_j}{n} = \frac{N}{n}. \qquad \text{(IV.2.2.)}$$

IV.3. The value of d ranges from 0 to 1. Zero indicates minimum disimilarity when all attributes of the two compared sampling units (or species) are the same. "1" indicates maximum dissimilarity which is obtained when the two quadrats (or species) differ from each other in all attributes.

IV.4. Sometimes it may be more convenient to use the term similarity. Then the values of the similarities between quadrats or species are the following:

$$e_{jk} = 1 - d_{jk} \qquad \text{(IV.4.1.)}$$

$$e_{hi} = 1 - d_{hi} \qquad \text{(IV.4.2.)}$$

V. Application of the weighted dissimilarity index to cluster analysis

V.1. The matrix of the dissimilarity values denoted by $D^{(0)}$ may be the starting point of numerous clustering algorithms. A method that regards the clusters as new individuals seems to be most applicable to this case. This is the "centroid sorting" method; its steps were briefly described by WILLIAMS, LAMBERT and LANCE (1966):

a. The most similar pair of quadrats are added together, attribute by attribute, to form a new synthetic quadrat.

b. The records of the pair concerned are deleted, together with all coefficients involving either of them.

c. Coefficients are calculated between the new quadrat and all other remaining quadrats. The process returns to operation a. If all quadrats are fused into a single group, then the analysis is terminated.

V.2. In the course of calculations the columns of the data matrix are reduced by one step by step. Elements of the synthetic quadrat obtained by the fusion of the most similar pair of quadrats are calculated according to the following formula:

$$f_{i(j,k)}^{(x+1)} = \frac{N_j \cdot f_{ij}^{(x)} + N_k \cdot f_{ik}^{(x)}}{N_j + N_k} \qquad \text{(V.2.1.)}$$

where $f_{ij}^{(x)}$ and $f_{ik}^{(x)}$ are the frequencies of species s_i in the fused quadrats t_j and t_k after x fusions. Its value ranges from 0 to 1. N_j and N_k are the numbers of quadrats fused in the columns j and k, respectively. If $N_j = N_k = 1$ the formula V.2.1. reduces to simpler form, for instance in the case of the first fusion:

$$f_{jk}^{(1)} = \frac{f_{ij}^{(0)} + f_{ik}^{(0)}}{2} \qquad \text{(V.2.2.)}$$

After $m - 1$ fusions the analysis is terminated and $(m - 1)^2$ coefficients are to be calculated. This is the reason why the centroid sorting method, especially in case of large samples, is a computer oriented one.

V.3. The same algorithm can be used for comparing pairs of species, but in this case the rows of the data matrix are to be fused. The number of fusions will be $n - 1$, the number of coefficients $(n - 1)^2$.

V.4. Let this algorithm be demonstrated by a hypothetical example. Let $U^{(0)}$ consist of 5 columns and 8 rows (5 quadrats and 8 species):

$U^{(0)} =$

	1	2	3	4	5
1	1	1	0	1	1
2	0	0	1	1	1
3	1	1	0	0	0
4	1	0	0	1	0
5	1	1	0	0	0
6	0	0	1	1	1
7	0	1	1	1	1
8	1	1	1	0	0

First the distribution $\hat{p}$ is to be calculated with the help of formula II.6.1., and, then we come to the following result:

$\hat{p} = 0.8, \quad 0.6, \quad 0.4, \quad 0.4, \quad 0.4, \quad 0.6, \quad 0.8, \quad 0.6$

Now we calculate matrix $D^{(0)}$ of the dissimilarity values according to formula IV.1.1. The semimatrix is given by

$D^{(0)} =$

	1	2	3	4	5
1	—	0.260	0.869	0.739	0.826
2		—	0.608	0.652	0.565
3			—	0.391	0.304
4				—	0.086
5					—

After the inspection of this matrix we find that the lowest dissimilarity is $d_{4,5} = 0.086$, thus we fuse quadrats 4 and 5 to obtain a new synthetic quadrat. We calculate the values of $f^{(1)}_{i,(4,5)}$ by the application of formula V.2.2. After the first fusion the starting binary data of the quadrats in question will represent new frequency values. The new data matrix is given by

$U^{(1)} =$

	1	2	3	(4, 5)
1	1	1	0	1
2	0	0	1	1
3	1	1	0	0
4	1	0	0	0.5
5	1	1	0	0
6	0	0	1	1
7	0	1	1	1
8	1	1	1	0

We compare the synthetic quadrat (4, 5) with all other quadrats and obtain matrix $D^{(1)}$:

$D^{(1)} =$

	1	2	3	(4, 5)
1	—	0.260	0.869	0.782
2		—	0.608	0.608
3			—	0.347
(4, 5)				—

After the first fusion we find that the quadrat 1 and 2 are the most similar pair, since $d_{1,2} = 0.260$. We calculate the new column of the data matrix and obtain matrix $U^{(2)}$:

$U^{(2)} =$

	(1, 2)	3	(4, 5)
1	1	0	1
2	0	1	1
3	1	0	0
4	0.5	0	0.5
5	1	0	0
6	0	1	1
7	0.5	1	1
8	1	1	0

Then we calculate matrix $D^{(2)}$:

$D^{(2)} =$

	(1, 2)	3	(4, 5)
(1, 2)	—	0.739	0.652
3		—	0.347
(4, 5)			—

where the lowest dissimilarity value is $d_{3,(4,5)} = 0.347$, so we fuse quadrat 3 and (4, 5). After this fusion the reduced data matrix is

$U^{(3)} =$

	(1, 2)	(3, 4, 5)
1	1	0.66
2	0	1
3	1	0
4	0.5	0.33
5	1	0
6	0	1
7	0.5	1
8	1	0.33

We compare the two columns of $U^{(3)}$ and obtain matrix $D^{(3)}$:

$D^{(3)} =$

	(1, 2)	(3, 4, 5)
(1, 2)	—	0.681
(3, 4, 5)		—

After the last fusion we get vector $\hat{p}$:

$$U^{(4)} = \hat{p} = \lfloor 0.8, \quad 0.6, \quad 0.4, \quad 0.4, \quad 0.4, \quad 0.6, \quad 0.8, \quad 0.6]$$

It is worth to summarize the steps indicating the fusion dissimilarities:

fusion 1	4. 5	$d = 0.086$
fusion 2	1, 2	$d = 0.260$
fusion 3	3, (4, 5)	$d = 0.347$
fusion 4	(1, 2), (3, 4, 5)	$d = 0.681$

The results are illustrated by the dendrogram in Fig. 1.

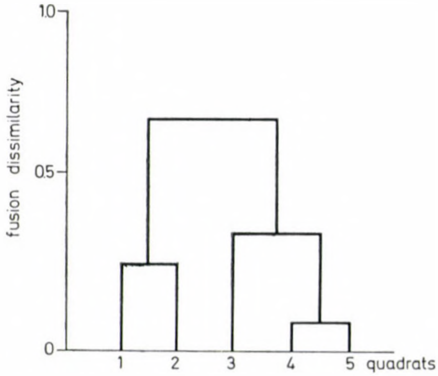

Fig. 1. Dendrogram constructed on the basis of centroid sorting method from data of the hypothetical example discussed in V. 4

VI. Application of the WDI to the study of a rocky grassland community

VI.1. The cluster analysis based on the WDI was applied to the study of a rocky grassland community from the Hungarian Central Range, which is considered to be an association named Seslerietum sadlerianae, and has been described according to the methodology of BRAUN-BLANQUET's school (ZÓLYOMI 1936, 1958; SOÓ 1964). This association is usually found on northern slopes on dolomite rocks (with the exception of Naszály Hill, where the rock is limestone).

33 sampling units of 4×4 m size from 7 stands of this community were examined. The distribution of the quadrats according to the stands is the following:

I.	Sashegy, Buda Hills	quadrats 1.—5.
II.	Hunyadorom, Buda Hills	quadrats 6.—9.
III.	Tündérszikla, Buda Hills	quadrats 10.—14.
IV.	Hármashatárhegy, Buda Hills	quadrats 15.—18.
V.	Nagykevély, Pilis Hills	quadrats 19.—23.
VI.	Pilistető, Pilis Hills	quadrats 24.—28.
VII.	Naszály Hill	quadrats 29.—33.

The geographic localisation of the stands is shown by Fig. 2.

147 species were found in the quadrats. Their comparison was also performed. Matrix of the presence-absence data is shown in Table 1.

VI.2. Computer program WDCL was written in FORTRAN IV for performing the cluster analysis of sampling units or species. A listing of it is available from the author on request.

VI.3. Dendrogram of the quadrats (Fig. 3) shows that the sampling units are clustered according to the stands. The only exception is quadrat 12.

At the level of $d = 0.354$ the quadrats from the stand of Naszály Hill differ from the rest of quadrats. This fact supports the view, that the stand of Naszály Hill represents a special type of this community. It was originally described as a "subassociation" named Seslerietum sadlerianae saxifragetosum aizoi (for details see ZÓLYOMI 1958; SOÓ 1964). This result was also obtained by the use of the association-analysis worked out by WILLIAMS and LAMBERT (PODANI 1976).

At the next level the cluster of quadrats 12, 15—18, 24—28 differ from the remaining quadrats. This level ($d = 0.27$) is lower than the dissimilarity between the cluster of quadrats 12., 24.—28. and the cluster of quadrats 15—18 ($d = 0.299$). Here we can find some other "monotonicity failures",* too (it is to be noted that in the cluster of species there are only two monotonicity failures, see Fig. 4). These failures are caused by the centroid

* In the sense of LANCE and WILLIAMS 1966.

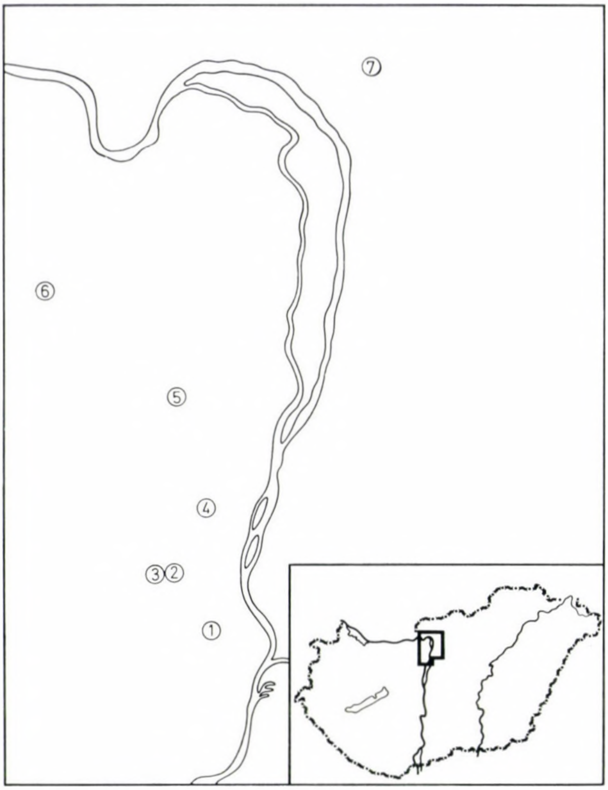

Fig. 2. Geographic localization of the stands of Seslerietum sadlerianae included in the study

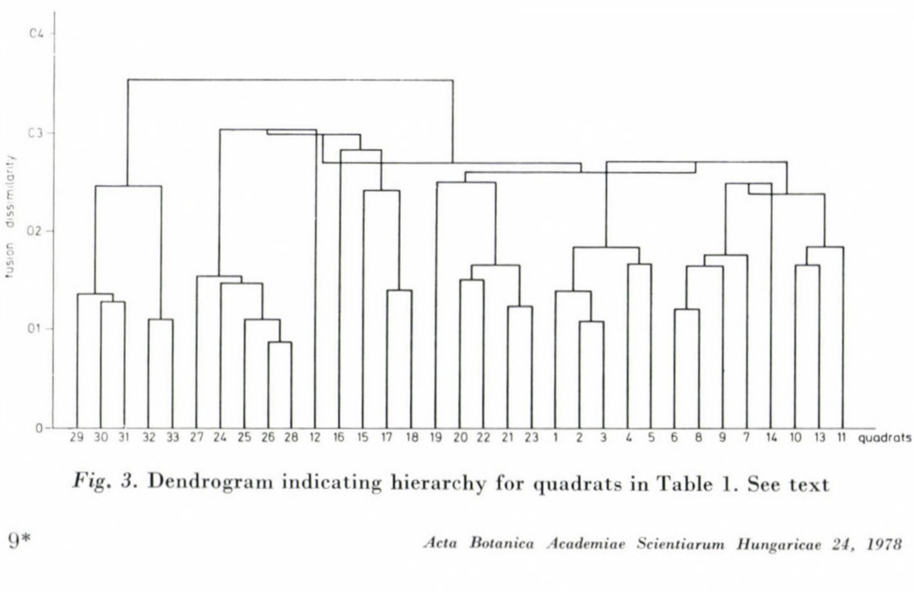

Fig. 3. Dendrogram indicating hierarchy for quadrats in Table 1. See text

Table 1

Matrix of the presence–absence data of species found in the stands of Seslerietum sadlerianae

Stand	Sashegy					Hunyadorom				Tündérszikla					Hármashatárh.				Nagykevély					Pilistető					Naszály				
Quadrat number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1. *Sesleria sadleriana*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2. *Sanguisorba minor*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1
3. *Draba lasiocarpa*	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
4. *Alyssum montanum*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	1	1	0	0
5. *A. alyssoides*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0
6. *Bupleurum falcatum*	1	1	0	1	1	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
7. *Jurinea mollis*	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
8. *Festuca pallens*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
9. *F. sulcata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0
10. *Seseli leucospermum*	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
11. *S. osseum*	1	1	1	0	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1
12. *S. hippomarathrum*	1	1	1	1	1	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13. *Carex humilis*	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
14. *C. liparocarpos*	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15. *Thymus praecox*	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0
16. *T. glabrescens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
17. *Globularia aphyllanthes*	1	1	1	1	1	1	1	0	1	1	0	0	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
18. *Polygonatum odoratum*	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	0	0	0	0	0
19. *Dianthus regisstephani*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20. *D. pontederae*	1	1	1	1	1	0	1	1	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	1	1	0	1	1	1	1	1
21. *Helianthemum canum*	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
22. *H. ovatum*	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	0	0	1	1
23. *Silene otites*	1	1	1	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
24. *Centaurea sadleriana*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	0	1	1	1	0	0	0	1	1
25. *C. micranthos*	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
26. *C. triumfettii*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27. *Scabiosa ochroleuca*	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	0	1	0	1	0	1	1
28. *S. canescens*	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29. *Thesium linophyllon*	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30. *Asperula glauca*	1	1	1	0	1	0	0	0	0	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0	1	1	0	1	1	0	1	1
31. *A. cynanchica*	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
32. *Stachys recta*	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	0	0	0	1	1	1	1	1
33. *Anthericum ramosum*	1	0	1	1	1	1	1	1	1	1	0	1	0	1	0	1	0	0	1	1	0	1	1	1	1	1	0	1	0	0	0	1	0
34. *Broms pannounicus*	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1	0	0	0	0	1	1	1	1	1

35. *Potentilla arenaria*	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1
36. *Odontites lutea*	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
37. *Anthyllis macrocephala*	0	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	0	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0
38. *Hieracium auriculoides*	0	1	0	1	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39. *H. bauhini*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	1	1	1	1
40. *Teucrium montanum*	0	1	0	1	1	1	1	1	1	0	0	0	0	1	0	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
41. *T. chamaedrys*	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	0	0	1	0	0	1	1	0	1	0	0	0	0	1	1
42. *Fraxinus ornus*	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	0	0	1	0	1	1	1	0	0	1	1	1	1	0	0	1	0	0
43. *Bisctutella laevigata*	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44. *Minuartia verna*	1	1	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
45. *M. setacea*	1	1	1	1	0	1	0	0	0	1	1	0	1	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	ä
46. *Dorycnium germanicum*	1	1	0	1	1	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
47. *Allium sphaerocephalum*	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48. *A. moschatum*	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
49. *A. flavum*	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0	1	0	1	1	1	0	1	0	1	1	1	1
50. *A. montanum*	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	1	1
51. *Linum tenuifolium*	1	1	1	1	0	1	1	1	1	0	0	1	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
52. *Sempervirum hirtum*	0	1	1	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	0	1	1	0
53. *Fumana procumbens*	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
54. *Scorzonera austriaca*	0	1	1	0	1	0	1	0	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
55. *S. purpurea*	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
56. *S. hispanica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57. *Hippocrepis comosa*	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58. *Euphorbia seguieriana*	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
59. *E. polychroma*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60. *E. cyparissias*	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0
61. *Cytisus hirsutus*	0	0	0	1	1	1	1	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	1	1	1	0	1	1	1	0	0
62. *C. procumbens*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63. *Reseda lutea*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64. *Erysimum odoratum*	0	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65. *Poa badensis*	0	0	0	0	0	1	1	1	1	1	0	0	0	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
66. *Veronica spicata*	0	0	1	1	1	1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
67. *V. austriaca*	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	1	1
68. *Asplenium rutamuraria*	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0
69. *A. trichomanes*	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
70. *Rumex acetosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71. *Arabis hirsuta*	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72. *A. recta*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
73. *Aster linosyris*	0	1	1	0	0	1	1	0	1	1	1	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74. *Cardaminopsis arenosa*	0	0	0	0	0	0	0	1	1	1	0	1	1	0	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0

(Contd.)

Stand	Sashegy					Hunyadorom				Tündérszikla					Hármashatárh.				Nagykevély					Pilistető					Naszály				
Quadrat number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
75. *Thalictrum minus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
76. *Sedum album*	0	0	0	0	0	1	0	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0
77. *S. acre*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
78. *S. maximum*	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
79. *S. sexangulare*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0
80. *Calamintha acinos*	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	1	0	0	0	0	1	1	1	1	1	1	1	1	0	1
81. *Melica ciliata*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	1	1	1	1	1	0	0	0	0
82. *Valeriana officinalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
83. *Geranium sanguineum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0
84. *G. columbinum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
85. *Medicago falcata*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
86. *M. prostata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
87. *Genista pilosa*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
88. *Trifolium campestre*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
89. *Coronilla varia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90. *C. coronata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
91. *Lotus borbásii*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
92. *Vicia tetrasperma*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0
93. *Pulsatilla grandis*	0	0	0	1	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	1	1
94. *Berberis vulgaris*	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95. *Adonis vernalis*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
96. *Aconitum anthora*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
97. *Ranunculus illyricus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
98. *Linaria genistifolia*	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
99. *Melampyrum cristatum*	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100. *Onosma visianii*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
101. *Echium vulgare*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
102. *Cynanchum vincetoxicum*	0	0	0	1	1	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	0
103. *Salvia pratensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
104. *Orobanche vulgaris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
105. *Cerastium pumilum*	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1
106. *Filipendula vulgaris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
107. *Cerasus mahaleb*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0

108. *C. fruticosa*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
109. *Trinia glauca*	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110. *Arenaria serpyllifolia*	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	1	1	0
111. *Cornus sanguinea*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112. *Dictamnus albus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
113. *Holosteum umbellatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0
114. *Campanula sibirica*	1	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
115. *C. rotundifolia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
116. *C. glomerata*	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117. *Inula ensifolia*	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
118. *Artemisia vulgaris*	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
119. *Taraxacum officinale*	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0
120. *Hypochoeris maculata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121. *Chrysanthemum corymbosum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
122. *Carduus collinus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0
123. *Muscari racemosum*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
124. *Iris variegata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
125. *Quercus pubescens*	0	0	0	0	1	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0
126. *Koeleria majoriflora*	0	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
127. *K. cristata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
128. *Stipa pennata*	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
129. *S. capillata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0
130. *Polygala comosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0
131. *Myosotis arvensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1
132. *Viola arvensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
133. *Phleum phleoides*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1
134. *Brachypodium pinnatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
135. *Thlaspi perfoliatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
136. *Primula veris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	1
137. *Arabidopsis thalliana*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
138. *Ceterach jávorkaeanum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0
139. *Spiraea media*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1
140. *Saxifraga paniculata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
141. *S. tridactylites*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
142. *Cystopteris fragilis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
143. *Valerianella locusta*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
144. *Hypericum perforatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1
145. *Luzula campestris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
146. *Galium verum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
147. *Lithospermum purpureocoeruleum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

sorting method itself, which does not exclude the possibility that the dissimilarity between two clusters is lower than between the quadrats fused in one of these clusters. This feature may be useful with respect to further considerations (besides, it does not reduce very much the clearness of the dendrogram).

Now I will not go into fruther details concerning the dendrogram of the quadrats. The relationships are shown by Fig. 3.

VI.4. Dendrogram of the species is illustrated in Fig. 4. According to this figure the species can be divided into two main groups ($d = 0.553$). The group consisting of 20 members contains the most frequent and perhaps the "most typical" species of the community. These species are absent from not more than 1—2 stands. These are the following (nomenclature of species follows Soó and Kárpáti 1968):

Carex humilis (13) and *Polygonatum odoratum* (18) are absent from Naszály Hill.

Scabiosa ochroleuca (27), *Allium flavum* (49), *Helianthemum ovatum* (22) and *Euphorbia cyparissias* (60) are absent from Sashegy.

Cytisus hirsutus (61) is absent from Nagykevély.

Asperula glauca (30) is the only species of this group which is absent from two stands (Hunyadorom and Nagykevély).

In the left part of the cluster of the other species group (from species 64 to species 117) we can find numerous frequent species but they are absent from 2—4 stands at least, and most of them are typical only in 2—3 stands. It is worth mentioning the case of *Festuca pallens* (8) which occurs in all quadrats of 5 stands but it is absent from 2 stands so it did not get into the group of typical species. There is only one species in this group, *Sempervivum hirtum* (52), which is present in all stands.

The rare species are clustered in the rightmost part of the dendrogram. A number of them are either typical in one stand (from species 28 to species 123) or present in 1—2 quadrats (from species 77 to species 120). It is striking that the values of dissimilarities are lower between the rare species than between the frequent ones. These low values, however, may be caused by some accidental effects which influence very much the dissimilarities between rare species. Thus, we can not draw general conclusions from these results. The situation is rather different in the case of frequent species although the dissimilarity values are relatively higher. But it is likely that the group of 20 species can also be found in stands that were not included in the analysis.

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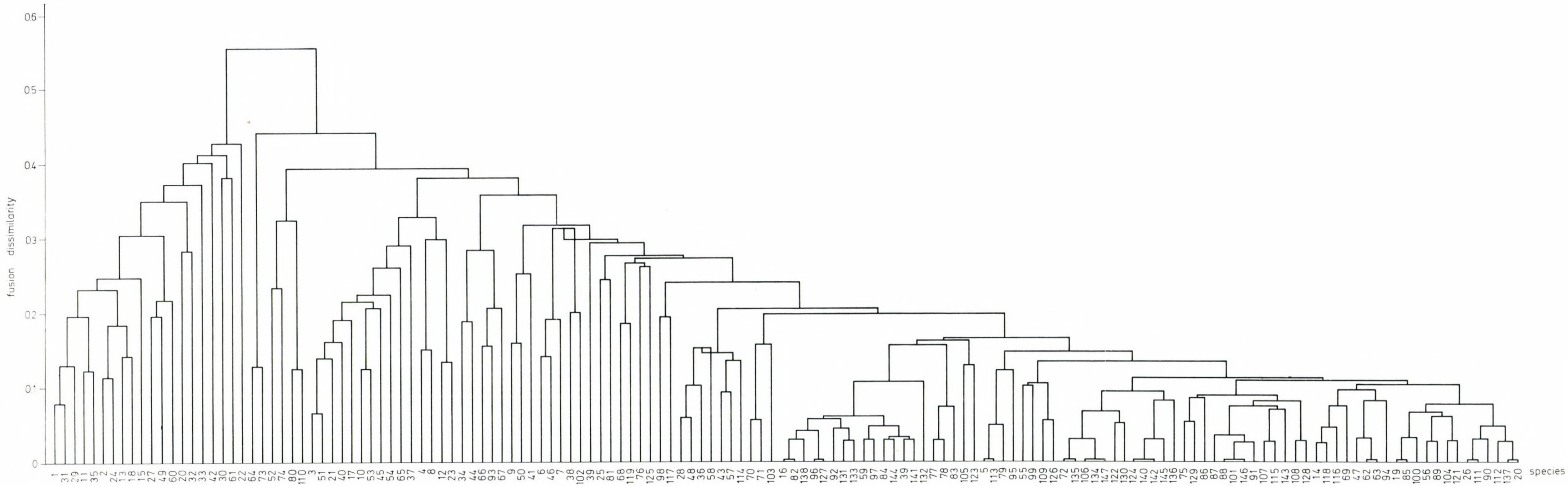

Fig. 4. Dendrogram indicating hierarchy for species in Table 1. See text

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STANDORTSTYPEN DER WALDGESELLSCHAFTEN IN UNGARN

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On the basis of detailed site surveys made on about 1500 places, of the records related to plant associations and of using the data published in cenological special literature, tables have been elaborated that indicate the relations between Hungarian forest associations and site types. The definition of the site type is based on the work of Z. Járó (1972).

According to this, the evaluation of the site types and their smaller units has been undertaken by means of a given scale of values referring to the following factors: climate, hydrology, soil type, textural make up of soil and its rootable depth. The forest associations were discussed according to the descriptions in the monography of Soó (1964 and 1973), but some of them — those not verified enough, or occurring in fragments, or in small areas — were omitted.

Die natürlichen Pflanzengesellschaften — unter ihnen auch die Waldassoziationen — stehen mit den auf ihre Umgebung Einfluss ausübenden ökologischen Faktoren, für kürzere oder längere Zeit, im Einklang. Darum muss zwischen ihnen und den an ihrem Standort zur Geltung kommenden wichtigsten ökologischen Faktoren notwendigerweise eine enge Verbindung zustande kommen.

Die meisten ungarischen zönologischen Arbeiten sind bestrebt, die Geltungmachung des obenerwähnten Grundprinzips darzustellen. Bei der Beschreibung der einzelnen pflanzensystematischen Einheiten haben die Autoren die Verbindung zwischen den Pflanzenassoziationen und den grundlegenden klimatischen Elementen untersucht und ihre Arbeit durch mikroklimatische und pedologische Beobachtungen ergänzt. Diese erstrecken sich aber sehr oft nur auf stichprobenartige Wahrnehmungen und knüpfen sich in günstigerem Falle an ausgewählte Mustergebiete an. Zur Darstellung umfassender Zusammenhänge sind jedoch mehrere Beobachtungen nötig.

Die ungarische Forstwissenschaft verwendet — sich auf die grundlegende Arbeit botanischer Forscher stützend — seit nahezu zwei Jahzehnten die Waldtypen und späterhin die Standortstypen. Damit erzielte sie die Produktivität der Wälder auf wissenschaftlicher Basis bestimmen und in der Baumartenwahl, sowie in der sicheren Verwendung verschiedener technologischer Verfahren objektiverweise entscheiden zu können.

Z. Járó (1972) interpretierte den Begriff des Standortstyps und jene wichtigen und grundlegenden ökologischen Faktoren, sowie Kennzeichen, die bei der Bestimmung des Standortstyps berücksichtigt werden müssen und die das Vorkommen und die Qualität der Wuchsverhältnisse der einzelnen Waldtypen entscheidend beeinflussen. Nach der Bestimmung des Begriffs des Standortstyps hat er auch das System der ungarischen Standortstypen bearbeitet. Diese Systematisierung diente demnach zur Basis, auf deren Grund unsere Waldgesellschaften und die sie beeinflussenden wichtigsten ökologischen Faktoren zusammen untersucht, und ihre Verbindung umfassend gewertet wurde.

Zur Bestimmung der Verbindung zwischen Standortstypen und Waldgesellschaften standen etwa anderthalb tausend Standorts-Feldaufnahmen und zur Beurteilung der einzelnen Waldgesellschaften nötig Aufzeichnungen zur Verfügung. Die Standortsaufnahmen wurden etwa zu fünfzig Prozent auch durch Laboruntersuchungen ergänzt. Zur Übersicht habe ich ausser meinen Aufnahmen auch das diesbezügliche Untersuchungsmaterial von J. ADORJÁN, I. BABOS, Z. JÁRÓ, A. MAJER, F. PALOTÁS verwendet; für ihre gefällige Hilfe spreche ich an dieser Stelle meinen besten Dank aus. Ausser obigen Materialien habe ich die in der ungarischen zönologischen Fachliteratur veröffentlichten und bei der Bewertung der Standortsbeziehungen der einzelnen Waldgesellschaften brauchbaren Daten und Feststellungen ebenfalls benutzt. Wegen Raummangel bin ich jedoch gezwungen die höchst zahlreichen literarischen Bezugnahmen wegzulassen und die Namen nur jener botanischen und forstwissenschaftlichen Autoren aufzuzählen, die Arbeiten deren in der Ergänzung des oben ausführlich dargelegten Aufnahmematerials einem nützlichen Anhaltspunkt bedeuteten: J. ADORJÁN, I. BABOS, Z. BARÁTH, O. BIRCK, A. BORHIDI, I. CSAPODY, P. JAKUCS, Z. JÁRÓ, M. KOMLÓDI, I. KÁRPÁTI, M. KOVÁCS, E. LÁNG, A. MAJER, T. PÓCS, Frau PÓCS, I. GELENCSÉR, T. SIMON, R. SOÓ, A. SZAPPANOS, I. SZODFRIDT, P. TALLÓS, Frau SZUJKÓ J. LACZA, B. TÓTH, I. TÓTH, B. ZÓLYOMI, J. ZSOLT.

1. Wertung der Standortstypen

Zur richtigen Wertung der ökologischen Beziehungen der Vegetationseinheiten müssen die bei der Zusammenstellung des Standortssystems angewandten Prinzipien dargelegt werden. Hier soll das Wesentliche zusammengefasst werden; weitere Informationen sind in der Arbeit von Z. JÁRÓ (1972) vorzufinden.

Zur Wertung des Standorts müssen fünf Faktoren berücksichtigt werden; diese sind der Reihe nach folgende: 1. Klima, 2. hydrologische Verhältnisse, 3. genetischer Bodentyp, 4. Boden-Tiefgründigkeit, 5. physikalische Art des Bodens. Die einzelnen Faktoren werden gesondert, mit Hilfe der unten beschriebenen Skala gewertet und der Standortstyp, bzw. seine kleineren Einheiten daraus bestimmt. Die Wertungsskala ist wie folgt:

Klima: 1. Buchenwald-Klima, 2. Eichen-Hainbuchenwald-Klima, 3. Zerreichen-Traubeneichenwald Klima (in den Tabellen kommt sie der Kürze zuliebe mit der Bezeichnung (»Eichenwald« vor), 4. Waldsteppenklima.

Hydrologische Verhältnisse: 1. grundwasserfern Standorte, 2. wechselfeuchte Standorte (im Weiteren: wechselnd), 3. hangsickerwasserbeeinflusste Standorte, 4. zeitweilig grundwasserbeeinflusste Standorte, 5. ständig grundwasserbeeinflusste Standorte, 6. oberflächenvernässte Standorte, 7. zeitweilig überflutete Standorte.

Bodentyp: wir gebrauchen die Bezeichnungen für genetische Bodentypen und statt ihrer ausführlichen Aufzählung verweisen wir nur auf die Arbeit von Z. JÁRÓ, sowie auf andere pedologische Facharbeiten.

Tiefgründigkeit: die Tiefgründigkeit wird auf Gebieten mit Buchenwald- und Eichen-Hainbuchenwald-Klimawirkung anders gewertet als auf denen mit Eichen- und Waldsteppen-Klimawirkungen. Von den angegebenen cm-Daten bezieht sich die erste auf die obenerwähnten zwei Klimagebiete, die zweite dagegen auf die zuletzt erwähnten zwei Klimagebiete. Die Kategorien der

Bodentiefgründigkeit sind folgende: 1. sehr flachgründig (0—20, bzw. 0—40 cm), 2. flachgründig (20—40, bzw. 40—60 cm), 3. mässig tiefgründig (40—60, bzw. 60—90 cm), 4. tiefgründig (60—90, bzw. 90—140 cm), 5. sehr tiefgründig (ab 100— bzw. 140 cm).

Physikalische Bodenart: 1. Schutt, 2. grober Sand, 3. Sand, 4. Lehm, 5. Ton, 6. schwerer Ton.

Aus den obigen können, wie aus Bausteinen, der Standortstyp und seine kleineren Einheiten zusammengestellt werden. Undzwar bekommen wir durch Angabe der entsprechenden Kategorien für Klima, hydrologische Verhältnisse und Boden den Standortstyp (z. B. Buchenwaldklima anzeigender, grundwasserferner Lessivé-Boden). Wenn wir dazu auch noch die Tiefgründigkeitskategorie angeben, bekommen wir den Untertyp des Standortstypus; wenn auch die physikalische Bodenart angegeben wird, gelangen wir zur Varietät des Standortstyps.

Mit Hilfe der bekanntgegebenen Klassifizierung wurden der Standortstyp, der Untertyp, die Standortsvarietät unserer Aufnahmen, sodann mit Hilfe der an den Aufnahmeflächen gefundenen Vegetation, die Pflanzengesellschaften bestimmt. Auf diese Weise standen uns zur Bestimmung des gesuchten Zusammenhangs zahlreiche Beobachtungen zur Verfügung.

Hinsichtlich der einzelnen Waldgesellschaften besassen wir keine gleichzähligen Daten. Das ist darauf zurückzuführen, dass die Datensammlung seinerzeit zum Zweck anderer Forschungsziele durchgeführt wurde, und auch das räumliche Vorkommen der einzelnen Waldgesellschaften nicht gleichmässig war. Darum war keine statistische Wertung möglich und so können wir nur folgendes angeben: an welchem Standortstypus, Untertypus und Varietät erscheinen die einzelnen Waldgesellschaften.

2. Wertung der Waldgesellschaften

Die Waldgesellschaften wurden in einer der ausgezeichneten vegetationssystematischen Monographie von R. Soó (1964—1973) entnommenen Reihenfolge behandelt. Seit der Veröffentlichung dieser Arbeit sind mehrere Studien publiziert worden, ausserdem ist die Interpretation gewisser Assoziationen bei einigen Autoren nicht identisch. Mit diesen Abweichungen haben wir im Laufe unserer Arbeit nicht gerechnet, da wir unser Ziel auch mit der angewandten Methode erreichen konnten; die inzwischen erfolgten Änderungen können mit den von Soó beschriebenen Kategorien in Einklang gebracht werden.

Das Vorkommen gewisser Assoziationen in Ungarn ist heute noch umstritten. Auch R. Soó bezeichnet ihr Vorkommen in seiner obenangeführten Arbeit öfters als problematisch. Andererseits gibt es mehrere solche Gesellschaften, deren heimisches Vorkommen fragmentarisch, oder derart begrenzt ist, dass

eine Standortsuntersuchung mit entsprechender Gründigkeit in ihnen nicht durchgeführt werden konnte. So beanspruchen die unten aufgezählten Gesellschaften weitere Untersuchungen, und demnach werden sie in meiner Abhandlung nicht besprochen: *Myricario-Epilobietum*, *Hippophäe-Salicetum*, *Salici cinereae-Sphagetum recurvi*, *Salici pentandrae-Betuletum pubescentis*, *Abieti-Fagetum*, *Tilio argenteae-Fraxinetum*, *Scutellario-Aceretum*, *Euphorbio-Quercetum*, *Genisto pilosae-Orno-Quercetum polycarpae*, *Poae pannonicae-Quercetum petraeae*, *Amygdaletum nanae pannonicum*, *Crataego-Cerasetum fruticosae*, *Pruno spinosae-Crataegetum*, *Chamaebuxo-Pinetum orientialpinum*, *Lino flavae-Pinetum*.

Die ökologischen Zusammenhänge befinden sich je nach Pflanzenassoziationen in den Tabellen, manchmal aber in den Beschreibungen. Wegen Raummangel konnte eine ausführliche Wertung nicht unternommen werden.

Salicetum purpureae

Wir besitzen keine Standortsaufnahmen über sie. Die aufgrund des Aspekts vorausgesetzten Standortsgegebenheiten sind folgende: Waldsteppenklima, zeitweilig überflutete hydrologische Kategorie, unreifer Auenboden, physikalische Bodenart: Sand (Csepel-Insel und Szigetköz) und Lehm (Csepel-Insel, Baja), sehr flachgründig. I. TÓTH berichtet (1958) über das Vorkommen der Gesellschaft auch auf einem Wiesenboden mit Waldsteppenklima und oberflächenvernässter hydrologischer Kategorie (entlang Vertiefungen ohne Abfluss), er hat jedoch die physikalische Bodenart und die Tiefgründigkeit nicht angegeben.

Salicetum triandrae

Klima	Hydrologie	Boden	Physikalische Art	Tiefgründigkeit
Waldsteppe	oberflächenvernässte	unreifer Auenboden	Lehm	sehr flachgründig
	zeitweilig überflutete Standorte			

Salicetum albae-fragilis

Klima	Hydrologie	Boden	Physikalische Art	Tiefgründigkeit
Waldsteppe u. Eichenwald	oberflächenvernässte	unreifer Auenboden	Sand	flachgründig
			Lehm	mässig tiefgründig
	ständig grundwasserbeeinflusste Standorte		Ton	mässig tiefgründig

Dryopteridi-Alnetum

Die Gesellschaft verdankt ihre Existenz vor allem den hydrologischen Gegebenheiten. So könnten die von uns angewandten hydrologischen Kategorien noch weiter verfeinert werden (ADORJÁN 1974). Um jedoch eine Übereinstimmung in der Arbeit bewahren zu können, wurden die ursprünglich beschriebenen Kategorien beibehalten. Es muss aber darauf hingewiesen werden, dass die systematische Beobachtung des Wassergangs unserer Erlenwälder eine bisher ungelöste Aufgabe darstellt.

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchen-, Eichen-Hainbuchenwald	zeitweilig überflutete und oberflächenvernässte Standorte	Moorboden	Sand	flachgründig
		Moorwiesenboden		
		Moorliegende	Lehm	
Eichenwald		Moorboden	Ton	sehr flachgründig
		Moorwiesenboden		
		Moorliegende		

Thelypteridi-Alnetum

Ihre Standorts- und ökologischen Gegebenheiten stimmen hochgradig mit denen der obenbehandelten Gesellschaft überein. Eigentlich kann zwischen ihnen nur aufgrund der in der zönologischen Literatur entsprechend detallierten floristischen Unterschiede eine Grenzlinie festgestellt werden.

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchenwald	zeitweilig überflutete und oberflächenvernässte Standorte	Moorboden Moorwiesenboden	Torf	flachgründig
Eichenwald		Moorboden		sehr flachgründig
		Moorwiesenboden	»Kotu«	

Fraxino pannonicae-Alnetum

Sie kommt unter ähnlichen Gegebenheiten, wie die obigen zwei Gesellschaften vor. Was ihr Verbreitungsareal anbelangt, so tritt sie vor allem im Waldsteppenklima auf, ist aber auch auf Gebieten mit Eichen-Hainbuchenwaldklima aufzufinden. Ihre hydrologische Kategorie: zeitweilig überflutet, der Bodentyp umfasst Moorböden und Moorwiesenböden. Es soll aber bemerkt werden, dass sie sich öfters auf Liegende mit alluvialem Ursprung befindet, wo die

Ackerkrume aus organischem Material entstandenen Bülten besteht. So ist ihre Tiefgründigkeit im Waldsteppen- und Eichenwaldklima sehr flach, und im Eichen-Hainbuchenwaldklima flach.

Calamagrosti-Salicetum cinereae

Sie kommt im Rahmen aller Klimatypen vor. Ihre hydrologischen Gegebenheiten können mit der zeitweilig überfluteten Kategorie charakterisiert werden. Den Bodentyp bilden Moorböden, Moorwiesenböden und in einigen Fällen Schwemmböden. Die physikalische Art ist im Falle der ersten zwei Bodentypen von organischem Material gekennzeichnet, in letzterem dagegen vom Lehm bestimmt. Sie zeigt eine flache, bzw. sehr flache Tiefgründigkeit. Wir bemerken, dass im Gegenteil zu der vorhergehenden Assoziation, der Wasserstand hier beständiger ist. Es besteht aber noch ein Unterschied, der erwähnenswert ist: die in Form von Stockausschlägen vorkommenden Bäume von *Frax. pann.-Alnetum* befinden sich meistens auf Bülten. Da in den Bülten eine bedeutende Masse organischen Materials zu finden ist, zeigt sich hier eine äusserst kleine Wasserhebung. So sind ihre Kronen zu Beginn des Sommers, nach dem Sinken des Wassers, trockener, und demnach befinden sich die Wurzeln für eine längere Zeit in einem lüftigerem Medium als die Wurzeln der Büsche von *Calamagrosti-Salicetum cinereae*, die nicht auf Bülten wachsen.

Carici remotae-Fraxinetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchenwald	oberflächenvernässte	zusammengeschwemmter Hangfussboden	schuttiger Lehm	flachgründig
	ständig grundwasserbeeinflusste Standorte	Wiesenboden	Lehm	mässig flachgründig
		zusammengeschwemmter Hangfussboden		

Carici brizoidi-Alnetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchen-, Eichen-Hainbuchenwald	oberflächenvernässte Standorte	zusammengeschwemmter Hangfussboden	Lehm	flachgründig
	ständig grundwasserbeeinflusste Standorte			mässig tiefgründig

Fraxino pannonicae-Ulmetum

Ihr Vorkommen hängt vor allem von der Höhenlage der Überschwemmungsgebiete, auf anderen flachländischen Gebieten dagegen von der Grundwassertiefe ab. So tritt sie in sämtlichen Klimakategorien auf.

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchenwald	ständig grundwasserbeeinflusst	unreifer Auenboden	Lehm	mässig tiefgründig
		Auenboden mit Humushorizont	Ton	tiefgründig
	zweitweilig grundwasserbeeinflusst	Auenboden mit Humushorizont	Lehm	mässig tiefgründig
Eichenwald	wechselfeuchte Standorte	Wiesenbraunerde	Ton	mässig tiefgründig
		alluvialer Waldboden		
	ständig grundwasserbeeinflusste Standorte	unreifer Auenboden	Lehm	mässig tiefgründig
		Auenboden mit Humushorizont	Ton	tiefgründig
	zeitweilig grundwasserbeeinflusste Standorte	Auenboden mit Humushorizont	Lehm Ton	mässig tiefgründig tiefgründig
		Wiesenbraunerde	Lehm	mässig tiefgründig
		alluvialer Waldboden	Sand	tiefgründig
Waldsteppe	ständig grundwasserbeeinflusste Standorte	Auenboden mit Humushorizont	Sand Lehm	mässig tiefgründig tiefgründig
		alluvialer Waldboden	Sand Lehm Ton	mässig tiefgründig
	zeitweilig grundwasserbeeinflusste Standorte	unreifer Auenboden	Sand	mässig tiefgründig
				tiefgründig
		Auenboden mit Humushorizont	Lehm	flachgründig
			Ton	mässig tiefgründig
		alluvialer Waldboden		tiefgründig
				mässig tiefgründig
				tiefgründig;

Carici acutiformi-Alnetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchenwald	oberflächenvernässte Standorte	zusammengeschwemmter Hangfussboden	Lehm	flachgründig
		Moorwiesenboden		
Eichen-Hainbuchenwald		zusammengeschwemmter Hangfussboden		
		Wiesenboden	Lehm Sand	
		Moorwiesenboden	Lehm	

Aegopodio-Alnetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchen-, Eichen-Hainbuchenwald	hangsickerwasserbeeinflusste Standorte	zusammengeschwemmter Hangfuss-Waldboden	Lehm	mässig tiefgründig
		Wiesenboden		
	ständig grundwasserbeeinflusste Standorte	zusammengeschwemmter Hangfuss-Waldboden		
	oberflächenvernässte Standorte	Wiesenboden	Sand, Lehm	flachgründig mässig tiefgründig
		Moorwiesenboden	Lehm	
		zusammengeschwemmter Hangfuss-Waldboden		

Aconito-Fagetum

Der in der Tabelle angegebene Rendzinaboden ist teilweise brauner, und teilweise schwarzer Rendzinaboden; wir verfügen jedoch auch über Aufnahmen, die auf rötlichem Rendzina verfertigt wurden. Aus den Standortstypen ist zu ersehen, dass diese Assoziation auf mannigfachen Bodentypen und meistens auf flacher Ackerkrume vorkommt, falls sie also ihre klimatischen Ansprüche erfüllen kann, verträgt sie auch die ungünstigeren Gegebenheiten der übrigen Standortsfaktoren leicht.

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchenwald	grundwasserferne Standorte	Rendzina	Schutt	flachgründig und mässig tiefgründig
			schuttiger Lehm	
			Ton	
		Ranker	schuttiger Lehm	mässig tiefgründig tiefgründig
		stark sauere Braunerde	schuttiger Lehm	mässig tiefgründig
		Braunerde	schuttiger Lehm	mässig tiefgründig
	wechselfeuchte Standorte[7]	Pseudogley-Braunerde	schuttiger Lehm	mässig tiefgründig

Laureolae-Fagetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchenwald	grundwasserferne Standorte	Rendzina	Ton	mässig tiefgründig
		Lessivé	schuttiger Lehm, Lehm	mässig tiefgründig tiefgründig
		Braunerde	Lehm	mässig tiefgründig
		Kovárvány-Braunerde	Sand	mässig tiefgründig tiefgründig
		zusammengeschwemmter Hangfuss-Waldboden	schuttiger Lehm Lehm	mässig tiefgründig tiefgründig
	hangsickerwasserbeeinflusste Standorte	Lessivé	Lehm	mässig tiefgründig tiefgründig

Dieser Typ kommt von den in der Tabelle angeführten Standortstypen am häufigsten vor und kann deshalb als der wichtigste Vorkommensort der Gesellschaft betrachtet werden; die Bodenart ist Lessivé, der Lehm als physikalische Art aufweist und mässig, bzw. sehr tiefgründig ist. An den übrigen Standortstypen tritt die Gesellschaft nur zerstreut auf.

Melittio-Fagetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchenwald	grundwasserferne Standorte	Rendzina	schuttiger Lehm	flachgründig mässig tiefgründig
		Ranker	schuttiger Lehm	flachgründig mässig tiefgründig
		stark sauere Braunerde	schuttiger Lehm Lehm	tiefgründig mässig tiefgründig
		podsolige Braunerde	schuttiger Lehm Lehm	mässig tiefgründig tiefgründig
		Lessivé	schuttiger Lehm Lehm	mässig tiefgründig tiefgründig sehr tiefgründig
		Braunerde	Lehm	mässig tiefgründig
		zusammengeschwemmter Hangfuss-Waldboden	schuttiger Lehm Lehm	mässig tiefgründig und tiefgründig
	wechselfeuchte Standorte	Pseudogley-Braunerde	schuttiger Lehm und Ton Lehm und Ton	mässig tiefgrün- tiefgründig
	hangsickerwasserbeeinflusste Standorte	Lessivé	Lehm	mässig tiefgründig tiefgründig
		zusammengeschwemmter Hangfuss-Waldboden	schuttiger Lehm	tiefgründig

Cyclamini-Fagetum

Die Gesellschaft tritt hauptsächlich — ähnlich der vorangehenden Assoziation — auf Lessivé mit den obenerwähnten Kennzeichen auf. Daher sind zur genaueren Trennung dieser zwei Gesellschaften weitere Untersuchungen nötig. Ihre Standortstypen wurden mit Rücksichtnahme auf obige Bemerkung zusammengestellt.

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchenwald	grundwasserferne Standorte	stark sauere Braunerde	schuttiger Lehm	flachgründig mässig tiefgründig
		podsolige Braunerde		mässig tiefgründig tiefgründig
		Lessivé	Lehm	mässig tiefgründig tiefgründig
	hangsickerwasserbeeinflusste Standorte	Lessivé	Lehm	mässig tiefgründig tiefgründig sehr tiefgründig
		zusammengeschwemmter Hangfuss-Waldboden		tiefgründig

Seslerio-Fagetum

Tritt im Buchenwaldklima auf grundwasserfernem, — ihre physikalische Art betreffend, — auf schuttigem, flachgründigem Rendzinaboden auf. Vermutlich kann man mit ihr auch auf sehr flachgründigem und flachgründigem, schuttigem Skelettboden rechnen.

Tilio-Sorbetum

Klima: Buchenwald; hydrologische Kategorie: grundwasserferne Standorte; Bodentyp: Skelettboden; physikalische Art: Schutt; Tiefgründigkeit: sehr flachgründig.

Phyllitidi-Aceretum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchen- und Eichen-Hainbuchenwald	grundwasserferne Standorte	Skelettboden	Schutt	sehr flachgründig
	hangsickerwasserbeeinflusste Standorte	erubaser Boden	schuttiger Lehm	sehr flachgründig flachgründig
		Rendzina	schuttiger Lehm	sehr flachgründig flachgründig

Parietario-Aceretum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchen-, Eichen-Hainbuchen-wald	grundwasserferne Standorte	Skelettboden	Schutt	sehr flachgründig
	hangsickerwasserbeeinflusste Standorte	zusammengeschwemmter Hangfussboden	schuttiger Lehm	flachgründig

Mercuriali-Tilietum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchenwald	grundwasserferne und hangsickerwasserbeeinflusste Standorte	Skelettboden	Schutt	sehr flachgründig
Eichenwald		erubaser Boden und Rendzina	schuttiger Lehm	flachgründig
			Lehm	

Querco petraeae-Carpinetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchenwald	grundwasserferne Standorte	Rendzina	schuttigler Lehm Lehm	mässig tiefgründig
		Ranker		flachgründig
				mässig tiefgründig
				tiefgründig
		Humus-Karbonat		mässig tiefgründig
		podsolige Braunerde		mässig tiefgründig
		Lessivé	Sand Lehm	mässig tiefgründig sehr tiefgründig
		Braunerde	Lehm	mässig tiefgründig
				tiefgründig
		Rostbraunerde	Sand	mässig tiefgründig
				tiefgründig
		Kovárvány Braunerde	Sand	tiefgründig
				sehr tiefgründig

Querco robori-Carpinetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchenwald	grundwasserferne Standorte	zusammengeschwemmter Hangfussboden	Lehm	mässig tiefgründig
		Lessivé	Sand Lehm	tiefgründig
				sehr tiefgründig
		Pseudogley-Braunerde	Lehm	mässig tiefgründig
		Rostbraunerde und Kovárvány-Braunerde	Sand	tiefgründig
				sehr tiefgründig
		Wiesenbraunerde	Sand	tiefgründig
				sehr tiefgründig
		zusammengeschwemmter Hangfuss-Waldboden	Lehm	mässig tiefgründig tiefgründig
	hangsickerwasserbeeinflusste Standorte	zusammengeschwemmter Hangfussboden	Lehm	mässig tiefgründig
		Lessivé	Lehm	tiefgründig sehr tiefgründig
		zusammengeschwemmter Hangfuss-Waldboden		
	zeitweilig grundwasserbeeinflusste Standorte	Lessivé und Rostbraunerde	Sand	tiefgründig
		Wiesenbraunerde	Sand	mässig tiefgründig
				tiefgründig
		zusammengeschwemmter Hangfuss-Waldboden	Lehm	mässig tiefgründig
				tiefgründig
	ständig grundwasserbeeinflusste Standorte	Lessivé und Rostbraunerde	Sand	mässig tiefgründig tiefgründig

Den Standortstypen ist zu entnehmen, dass diese Gesellschaft einen entweder tiefgründigen, oder sehr tiefgründigen, also einen guten Wasserhaushalt besitzenden Boden beansprucht, oder sie erfordert Wasser in einer den Wurzeln zugänglichen Tiefe.

Aceri campestri-Quercetum petraeae-roboris

Klima der Gesellschaft: Eichenwald; hydrologische Kategorie: grundwasserferner Standort; Bodentyp: Braunerde, bzw. Rostbraunerde auf mässig tiefgründigem Lehm, bzw. Sand.

Fraxino pannonicae-Carpinetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchenwald	grundwasserferne Standorte	zusammengeschwemmter Hangfussboden	Lehm	tiefgründig
				sehr tiefgründig
	wechselfeuchte Standorte	Wiesenbraunerde, alluvialer Waldboden	Ton	mässig tiefgründig
				tiefgründig
	hangsickerwasserbeeinflusste Standorte	zusammengeschwemmter Hangfussboden zusammengeschwemmter Hangfuss-Waldboden	Lehm	mässig tiefgründig
				tiefgründig
	zeitweilig grundwasserbeeinflusste Standorte	Wiesenbraunerde alluvialer Waldboden zusammengeschwemmter Hangfuss-Waldboden	Lehm	mässig tiefgründig
				tiefgründig
	ständig grundwasserbeeinflusste Standorte	Wiesenbraunerde alluvialer Waldboden zusammengeschwemmter Hangfuss-Waldboden	Lehm	mässig tiefgründig

Aus der Tabelle ist ersichtlich, dass der Aspekt der Gesellschaft, ausser dem Klima, vor allem von den hydrologischen Gegebenheiten bestimmt ist. Die Assoziation kann auf mehreren Bodentypen vorkommen, die Tiefe der Ackerkrume ist von der hydrologischen Kategorie kompensiert.

Helleboro dumetorum-Carpinetum

Der Grossteil unserer Aufnahmen wurde auf Lessivé verfertigt. Die Gesellschaft kommt auch auf verkrüppeltem, durch Erosion verdünntem Lessivé vor. Ebenfalls tritt sie auf einem, durch Erosion nahezu bis zum Grundgestein

degradierten, sodann eine sekundäre Humifikation zeigenden und sich in der Richtung der Braunerde mit Karbonatrückständen entwickelnden Boden auf. Dies bedeutet jedoch das ökologische Extreme ihres Vorkommens.

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchenwald	grundwasserferne Standorte	Lessivé	Sand Lehm	mässig tiefgründig
				tiefgründig
				sehr tiefgründig
		Braunerde	Lehm	mässig tiefgründig
				tiefgründig
		Rostbraunerde	Sand	mässig tiefgründig
				tiefgründig
	hangsickerwasserbeeinflusste Standorte	zusammengeschwemmter Hangfussboden Lessivé	Lehm	mässig tiefgründig
				tiefgründig
				tiefgründig
				sehr tiefgründig
		zusammengeschwemmter Hangfuss-Waldboden		tiefgründig
				sehr tiefgründig

Asperulo taurinae-Carpinetum

Klima	Bodentyp	Hydrologie	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchenwald	grundwasserferne Standorte	Lessivé	Lehm	mässig tiefgründig tiefgründig sehr tiefgründig
		Braunerde		mässig tiefgründig tiefgründig

Es ist der Mühe wert, diese Gesellschaft mit den Standortstypen von *Helleboro dumetorum-Carpinetum* zu vergleichen. Zwischen beiden Gesellschaften besteht vielleicht allein der Unterschied, dass *Helleboro-dumetorum-Carpinetum* eine breitere ökologische Streuung zeigt. In ihren wesentlichen Zügen stimmen sie dagegen überein, so ist ihre Teilung in zwei selbständige Gesellschaften — von seiten der Ökologie — fragwürdig.

Vicio oroboidi-Fagetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchenwald	grundwasserferne Standorte	Lessivé	Lehm	mässig tiefgründig
				tiefgründig
				sehr tiefgründig
		zusammengeschwemmter Hangfuss-Waldboden		mässig tiefgründig tiefgründig
	wechselfeuchte Standorte	Pseudogley-Braunerde	Lehm + Ton	mässig tiefgründig
				tiefgründig
	hangsickerwasserbeeinflusste Standorte	Lessivé	Lehm	mässig tiefgründig
				tiefgründig
				sehr tiefgründig
		zusammengeschwemmter Hangfuss-Waldboden		mässig tiefgründig
				tiefgründig

Helleboro odoro-Fagetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchenwald	grundwasserferne Standorte	Lessivé	Lehm	mässig tiefgründig
				tiefgründig
				sehr tiefgründig
		zusammengeschwemmter Hangfuss-Waldboden	Lehm schuttiger Lehm	mässig tiefgründig
				tiefgründig
	hangsickerwasserbeeinflusste Standorte	Lessivé	Lehm	mässig tiefgründig
				tiefgründig
		zusammengeschwemmter Hangfuss-Waldboden		sehr tiefgründig

Laut unseren Aufnehmen tritt sie unter nahezu gleichen ökologischen Umständen, wie *Vicio oroboidi-Fagetum* auf.

Castaneo-Quercetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchenwald	grundwasserferne Standorte	stark sauere Braunerde	Lehm schuttiger Lehm	flachgründig
				mässig tiefgründig
		podsolige Braunerde	Lehm	mässig tiefgründig
	wechselfeuchte Standorte	Pseudogley-Braunerde	Lehm schuttiger Lehm	mässig tiefgründig

Für die Gesellschaft sind die flachgründigen, in höherem Grade saueren Bodentypen charakteristisch. Die künstlich angebauten Edelkastanienwälder kommen vor allem auf Lessivé mit Eichen-Hainbuchenwaldklima und in der hydrologischen Kategorie der grundwasserfernen Standorte vor, so nehmen sie den Platz der einstigen Eichen-Hainbuchenwälder ein. Die Bemerkung von Soó (1964), dass die pannonischen Kastanienwälder Kulturprodukte seien, mag von seiten der Ökologie unterstützt werden.

Luzulo-Querco-Carpinetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchenwald	grundwasserferne Standorte	stark sauere Braunerde	Lehm	mässig tiefgründig
		podsolige Braunerde		mässig tiefgründig tiefgründig

Genisto tinctoriae-Quercetum petraeae

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchenwald	grundwasserferne Standorte	erubaser Boden	schuttiger Lehm	flachgründig
		Ranker	schuttiger Lehm	mässig tiefgründig
		stark sauere Braunerde	schuttiger	flachgründig
				mässig tiefgründig
		podsolige Braunerde	Lehm schuttiger Lehm	mässig tiefgründig
	wechselfeuchte Standorte	Pseudogley-Braunerde	Ton	mässig tiefgründig

Aufgrund der Tabelle kann festgestellt werden, dass die Gesellschaft im allgemeinen auf flachgründigen, eine schuttige Ackerkrume zeigenden Böden auftritt, demnach ist auch der Wasserhaushalt des Bodens schwächer. Damit kann erklärt werden, dass sich im Eichen-Hainbuchenwaldklima anstatt eines Eichenwaldes mit Hainbuchen in der zweiten Kronenschicht nur einstufige Eichenwälder entwickeln konnten.

Genisto nervatae-Pinetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchenwald Eichen-Hainbuchenwald	wechselfeuchte Standorte	Pseudogley-Braunerde	Ton	mässig tiefgründig tiefgründig
	grundwasserferne Standorte	Rostbraunerde	Sand	mässig tiefgründig

Während die *styriacum*-Varietät der Assoziation (Soó 1973) auf dem Vend-Gebiet auftritt und durch Pseudogley-Braunerde, Buchenwaldklima und wechselfeuchte Standorte charakterisiert werden kann, kommt die *praenoricum*-Varietät des Gebiets zwischen der Landesgrenze und des Bakony-Gebirgsfusses bereits im Eichen-Hainbuchenwaldklima, auf Lessivé vor, wogegen die dritte Varietät, *arrabonicum*, am Fusse des Bakony-Gebirgs im Eichen-Hainbuchenwaldklima, auf sandige physikalische Art zeigender Rostbraunerde zu finden ist. All dies verweist darauf, dass es — trotz der floristischen Ähnlichkeit — der Mühe wert ist, die Neusystematisierung der Gesellschaft vorzunehmen.

Aulacomnio-Pinetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchenwald	wechselfeuchte Standorte	Pseudogley-Braunerde	Lehm	mässig tiefgründig
			Ton	

In ökologischer Hinsicht ist sie von der vorangehenden Gesellschaft nicht scharf zu trennen. Ihre Bestände auf dem Vend-Gebiet kommen im Buchenwaldklima, auf wechselfeuchte Standorte zeigenden Pseudogley-Braunerden vor, undzwar unter ähnlichen Umständen wie die *styriacum*-Varietät der vorhergehenden Gesellschaft. Die ökologische Begründung der Trennung beider Gesellschaften soll von weiteren Untersuchungen geklärt werden.

Galio rotundifoliae-Fagetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchenwald	grundwasserferne Standorte	zusammengeschwemmter Hangfuss-Waldboden	Lehm	mässig tiefgründig
				tiefgründig
	wechselfeuchte Standorte	Pseudogley-Braunerde	Ton	mässig tiefgründig
				tiefgründig
	hangsickerwasserbeeinflusste Standorte	zusammengeschwemmter Hangfuss-Waldboden	Lehm	mässig tiefgründig

Orno-Luzulo-Fagetum

Wir besitzen nur eine einzige Aufnahme von dieser Gesellschaft. Aufgrund deren tritt die Assoziation im Buchenwaldklima, in grundwasserferner-hydrologischer Kategorie, auf schuttartigen und mässig tiefgründigen, stark saueren Braunerden auf.

Querco cerri-Luzulo-Fagetum

Eigene Aufnahmen besitzen wir von dieser Gesellschaft nicht, statt solcher müssen wir uns auf die Vorzählung von literarischen Angaben beschrenken. Nach diesen erscheint sie laut ZÓLYOMI—JAKUCS—BARÁTH—HORÁNSZKY (1954) auf primär podsoligem (sauere Braunerde?) und flachgründigem, stark podsolisiertem (nach unserer heutigen Nomenklatur handelt es sich vermutlich um podsolierte Braunerde) Boden, während T. SIMON (1971) sie auf Podsolranker (das Äquivalent in unserer heute gebräuchlichen genetischen Bodensystematik soll noch erforscht werden) und auf pseudogleyischer, bzw. podsoliger Braunerde, ferner auf zusammengeschwemmtem Hangfussboden vorgefunden hat. Ausser den obenerwähnten Kategorien sind grundwasserferne, bzw. hangsickerwasser-beeinflusste Standorte (im Falle von zusammengeschwemmtem Hangfussboden) möglich. Klima: Buchenwaldklima.

Cotino-Quercetum pubescentis

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichenwald	grundwasserferne Standorte	Rendzina	schuttiger Lehm	mässig tiefgründig
		Humus-Karbonat	Lehm	

Cotoneastro tomentosi-Amelanchieretum

In ökologischer Hinsicht ist sie eine wenig untersuchte Gesellschaft. Sie kommt im Eichen-Hainbuchenwaldklima und im Eichenwaldklima gleicherweise vor. Ihre hydrologische Kategorie: grundwasserferne Standorte. Bodentyp: Skelettboden. Physikalische Art: Schutt, Tiefgründigkeit: flachgründig.

Fago-Ornetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchenwald	grundwasserferne Standorte	Rendzina	schuttiger Lehm	flachgründig

Die Zahl unserer Aufnahmen reicht zur endgültigen ökologischen Wertung nicht aus.

Orno-Quercetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichenwald	grundwasserferne Standorte	Rendzina	schuttiger Lehm	flachgründig
				flachgründig
				mässig tiefgründig
			Ton	flachgründig
				mässig tiefgründig
		Humus-Karbonat	Lehm	flachgründig
				mässig tiefgründig
		Braunerde		mässig tiefgründig
		Tschernozem-Braunerde		flachgründig mässig tiefgründig

Quercetum petraeae-cerris

Aus der Tabelle ist die Mannigfaltigkeit der ökologischen Gegebenheiten zu ersehen. Am häufigsten kommt in der grundwasserfernen Kategorie eine mässig tiefgründige, oder tiefgründige Braunerde und Rostbraunerde vor. Ebenfalls häufig tritt die Gesellschaft auf Lessivé auf. Ausser den natürlichen Zerreichenwäldern verfügen wir über zahlreiche künstlich gezüchteten Zer-

reichenwälder. Diese sind vor allem im Eichen-Hainbuchenwaldklima und eher auf tieferem Lessivé zu finden.

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichenwald	grundwasserferne Standorte	zusammengeschwemmter Hangfussboden	Lehm	flachgründig
				mässig tiefgründig
		Rendzina	Ton	mässig tiefgründig
		Ranker	Lehm	mässig tiefgründig
				tiefgründig
		Lessivé		mässig tiefgründig
		Braunerde		mässig tiefgründig
				tiefgründig
		Rostbraunerde	Sand	mässig tiefgründig
				tiefgründig
		Kovárvány-Braunerde		mässig tiefgründig
				tiefgründig
		Tschernozem-Braunerde	Lehm	mässig tiefgründig
		Braunerde mit Karbonatrückständen		mässig tiefgründig
				tiefgründig

Tilio argenteae-Quercetum petraeae (resp. dalechampii-cerris)

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichenwald	grundwasserferne Standorte	Lessivé	Lehm	mässig tiefgründig
		Braunerde	Lehm	mässig tiefgründig
				tiefgründig
		Rostbraunerde	Sand	mässig tiefgründig tiefgründig
		Tschernozem-Braunerde	Lehm	mässig tiefgründig

Deschampsio-Quercetum robori-cerris

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchenwald	wechselfeuchte Standorte	Pseudogley-Braunerde	Ton und Lehm	mässig tiefgründig
				tiefgründig

Asphodelo-Quercetum robori-cerris

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchenwald	grundwasserferne Standorte	Lessivé	Sand	mässig tiefgründig
				tiefgründig
		Rostbraunerde		mässig tiefgründig
				tiefgründig
		Kovárvány-Braunerde		mässig tiefgründig
				tiefgründig

Die Gesellschaft kommt in erster Reihe auf Bodentypen vor, die sich aus schotterigem Sandgrundgestein herausbildeten. Innerhalb des Eichen-Hainbuchenwaldklimas tritt sie im allgemeinen dort auf, wo sich das Terrain erhöht und der Grundwasserspiegel von den Wurzeln nicht zu erreichen ist. In der Somogyer Gegend dient dieser Umstand zur Trennung von den Eichen-Hainbuchenwäldern (*Fraxino pann.-Carpinetum*).

Quercetum robori-cerris

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichenwald	wechselfeuchte Standorte	Pseudogley-Braunerde	schotteriger Lehm und Ton	flachgründig
				mässig tiefgründig

Genisto pilosae-Quercetum petraeae

Laut unseren Aufnahmen kommt sie auf sauerem Grundgestein entstandenen Skelettboden, sowie auf einem entwickelteren, bereits als stark sauere Braunerde klassifizierbaren, aber infolge der Flachgründigkeit immer zur Austrocknung neigenden Boden vor.

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchenwald und Eichenwald	grundwasserferne Standorte	Skelettboden	Schutt	sehr flachgründig
		stark sauere Braunerde	schuttiger Lehm	flachgründig

Ceraso (mahaleb)-Quercetum pubescentis

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchen- und Eichenwald	grundwasserferne Standorte	Rendzina	schuttiger Lehm Lehm	sehr flachgründig
				flachgründig

Festuco pseudodalmaticae-Ceraso (mahaleb)-Quercetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchen- und Eichenwald	grundwasserferne Standorte	Erubas Boden	schuttiger Lehm Lehm	sehr flachgründig
				flachgründig

Waldsteinio-Spiraeetum mediae

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Buchenwald	grundwasserferne Standorte	Skelettboden	Schutt	sehr flachgründig
Eichen-Hainbuchenwald		Skelettboden	Schutt	sehr flachgründig
		Erubas Boden Rendzina	schuttiger Lehm	sehr flachgründig

Tilio-Fraxinetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichen-Hainbuchen- und Eichenwald	grundwasserferne Standorte	Skelettboden	Schutt	sehr flachgründig
		Rendzina	schuttiger Lehm	
		Erubas Boden		

Die Tabelle weist darauf hin, dass die Standortstypen der vorhin und jetzt behandelten Gesellschaften übereinstimmen. Daher sind zwecks weiterer Verfeinerung ergänzende Untersuchungen nötig.

Aceri tatarico-Quercetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Waldsteppe	grundwasserferne Standorte	Humus-Karbonat	Lehm	sehr flachgründig
				flachgründig
		Rostbraunerde	Sand	mässig tiefgründig
		Tschernozem-Braunerde und Braunerde mit Karbonatrückständen	Lehm	flachgründig
				mässig tiefgründig

Dictamno-Tilietum cordatae

In zönologischer und ökologischer Hinsicht eine nur von dem Gödöllőer Hügelland bekannte Gesellschaft. Aufgrund der von hier stammenden Aufnahmen wurde der Standortstyp angegeben. Dementsprechend kommt die Gesellschaft im Hainbuchen—Eichenwaldklima, in der hydrologischen Kategorie der grundwasserfernen Standorte, auf sandige physikalische Art zeigendem, flachgründigem und mässig tiefgründigem Lessivé vor. Die Gesellschaft tritt vermutlich auch in anderen Landesteilen auf Umgebung von Kisbér; ihre weitere Untersuchung wäre wünschenswert.

Orno-Quercetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichenwald	grundwasserferne Standorte	Rendzina und Erubas Boden	schuttiger Lehm	sehr flachgründig
				flachgründig
		Ranker		flachgründig
				mässig tiefgründig
		Braunerde		mässig tiefgründig
		Humus-Karbonat	Lehm	flachgründig mässig tiefgründig

Festuco-Quercetum

Eine in ökologischer Hinsicht noch weitere Untersuchungen beanspruchende Gesellschaft. Aus ihrer bisherigen zönologischen Beschreibung kann man darauf schliessen, dass die Entstehung der Gesellschaft auch durch anthropogene Faktoren beeinflusst wurde. Andererseits haben sich ihre Bestände in der Sandsteppe des Donau—Theiss-Zwischenstromlandes derart verringert, dass — meiner Meinung nach — vor dem Beginn eingehender ökologischer Untersuchungen die zönologische Untersuchung der Verbreitung, des natürlichen Aspekts der Gesellschaft vorgenommen werden sollte. Die Zusammenstellung ihrer Standortstypen kann deshalb nicht als endgültig gelöst betrachtet werden.

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Waldsteppe	grundwasserferne Standorte	Tschernozem-Braunerde und Braunerde mit Karbonatrückständen	Sand	mässig tiefgründig
	zeitweilig grundwasserbeeinflusste Standorte	Rostbraunerde		
	ständig grundwasserbeeinflusste Standorte	schwach humoser Sand		tiefgründig
				mässig tiefgründig

Junipero-Populetum albae

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Waldsteppe	grundwasserferne Standorte	schwach humoser Sand	Sand	flachgründig
		Braunerde mit Karbonatrückständen		
	zeitweilig grundwasserbeeinflusste Standorte	schwach humoser Sand		

Convallario-Quercetum

Aus der Tabelle stellt sich heraus, dass die Eichenwaldgesellschaft mit Maiglöckchen mehr oder minder an Grundwasser gebunden ist. In ökologischer Hinsicht steht sie der *Fraxino pannonicae-Ulmetum*-Assoziation sehr nahe. Es wäre daher zu bedenken, ob es nicht richtiger wäre, die *Convallario-Quercetum*-Gesellschaft aus den trockenen Eichenwäldern herausgehoben eher in

einen anderen Assoziationsverband vielleicht in eine andere Ordnung einzureihen.

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Waldsteppe	grundwasserferne Standorte	Rostbraunerde	Sand	tiefgründig
		Wiesenboden und ihre Kombinationen		
	zeitweilig grundwasserbeeinflusste Standorte	Auenboden mit Humushorizont	sandiger Lehm	mässig tiefgründig
		Rostbraunerde	Sand	tiefgründig
		Kovárvány-Braunerde		mässig tiefgründig
		Wiesboden und ihre Kombinationen		tiefgründig
		Wiesenbraunerde		mässig tiefgründig
	ständig grundwasserbeeinflusste Standorte	Wiesenboden und ihre Kombinationen	Sand	mässig tiefgründig
		Wiesenbraunerde		mässig tiefgründig
				tiefgründig

Festuco pseudovinae-Quercetum

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Waldsteppe	wechselfeuchte Standorte	Wiesenbraunerde	Ton	mässig tiefgründig
	zeitweilig grundwasserbeeinflusste Standorte		Lehm	

Die in der Tabelle angeführte Wiesenbraunerde kann teilweise den in der Tiefe salzigen, teilweise aber den Wiesenbraunerden mit Solonetz zugeordnet werden.

Crataegetum danubiale

Der Standortstyp ist folgender: Klima: Waldsteppe; Hydrologie: grundwasserferne Standorte; Boden: unreifer oder Auenboden mit Humushorizont; physikalische Art: Sand; Tiefgründigkeit: sehr flachgründig.

Festuco vaginatae-Pinetum silvestris

Klima	Hydrologie	Bodentyp	Physikalische Art	Tiefgründigkeit
Eichenwald	grundwasserferne Standorte	schwach humoser Sand	Sand	flachgründig
		Rostbraunerde (krüppelhaft)		

Bazzanio-Abietetum

Klima	Bodentyp	Hydrologie	Physikalische Art	Tiefgründigkeit
Buchenwald	wechselfeuchte Standorte	Pseudogley-Braunerde	Ton	mässig tiefgründig
	hangsickerwasserbeeinflusste Standorte	zusammengeschwemmter Hangfuss-Waldboden	Lehm	

Zusammenfassung

Aufgrund von ung. an 1500 Standorten verfertigten Aufnahmen und den beigefügten, auf die Pflanzengesellschaften hinweisenden Bemerkungen, sowie mittels Anwendung der in der zönologischen Literatur veröffentlichen Angaben wurden die Tabellen zusammengestellt, die die Zusammenhänge zwischen den ungarischen Waldassoziationen und ihren Standortstypen darstellen. Bei der Bestimmung des Standortstyps wurde die Arbeit von Z. Járó (1972) als Grundlage angenommen. Nach dieser mussten zur Beurteilung des Standortstyps und der kleineren Einheiten folgende Faktoren mittels einer angegebenen Wertskala bestimmt werden: Klima, Hydrologie, Bodentyp, physikalische Art des Bodens und Boden- Tiefgründigkeit. Die Waldgesellschaften wurden den in der Monographie von Soó (1964—1973) beschriebenen Assoziationen gemäss behandelt, einige dagegen — die nicht ausreichend geklärt worden sind, oder die nur fragmentarisch, in kleiner Verbreitung vorkommen — wurden weggelassen.

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FUNCTIONAL STATES OF THE PHOTOSYNTHETIC APPARATUS OF THE MARINE GREEN ALGA *ULVA FENESTRATA* DURING THE DAY

By

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The marine green alga *Ulva fenestrata* has been studied in relation to changes of visible and potential photosynthesis, optical density, content of photosynthetic pigments and chloroplast position. During the summer months the rate of visible photosynthesis was observed to reach its maximum by 10 o'clock in the morning remaining constant up to 12.00—13.00 with gradual postmeridian decrease. The rates of potential photosynthesis were also noticed to peak at midday. However, potential photosynthesis exhibited occasional midday depressions. The alga chloroplasts showed regular migrations from the inner cell wall toward the outer one from 6.00 to 10.00 in the morning and a backward motion from 12.00. The optical density of the thalli increased by 10.00—13.00 up to 30—40% of the initial value and dropped gradually to reach a constant value by 21.00. The content of chlorophyll and lutein fractions showed a midday increase and a subsequent evening drop. A reverse picture was evident for changes of the violaxanthine content. The carotene content was observed to grow during a day. It has been found that the trends of the changes of the main parametres of the *Ulva fenestrata* photosynthetic apparatus under daylight appeared to be regulated endogenically, their ranges being considerably determined by light conditions.

Introduction

Marine green alga *Ulva fenestrata* is widely distributed in the Pacific Ocean. Variability of species has been studied both morphologically and anatomically (Kussakin, 1958; Vinogradova, 1974). The analysis of herbarium material and field observations showed significant ecological lability of the alga: it was found to inhabit a wide range of light and temperature environments and to withstand considerable water pollution.

Like other species of the genus, *Ulva fenestrata* is characterized by high productivity: it stores large amounts of starch, being thus commercially promising (Kalugina-Gutnik, 1975). The algae thalli being large and uniformly pigmented, are composed of two layers of cells containing one large chloroplast that makes them most suitable for physiological and biophysical experiments. Different species of the genus are widely used for multiple studies.

We used *Ulva fenestrata* for several years to study light adaptation of alga photosynthetic apparatus. The alga adaptation to low light intensities has been found with increased photosynthetic pigment contents, changed

ratio of the pigments and chlorophyll aggregations along with increased volumes and concentrations of thylakoid membranes in a strome (TITLYANOV and ZVALINSKY, 1971; ZVALINSKY and SEMENKOVA, 1974; TITLYANOV et al., 1974, 1975). The above changes are responsible for higher potential capacities of the alga photosynthesis.

Throughout a year the main structural and functional parameters of the *Ulva fenestrata* photosynthetic apparatus vary depending on changes of external (light and temperature) and internal (generative cycles) conditions (KOTLYAROVA, 1974; LEE, 1974; KOLMAKOV and TROFIMOVA, 1974; TITLYANOV et al., 1975).

The paper presents a study of the algal assimilation function affected by external and internal factors during the day.

Materials and methods

The studies were carried out in August, 1973 and 1974 and in July—October, 1975, in Peter the Great Bay (Japan Sea) at the Stark biological station of the Institute of Marine Biology.

The algae were sampled at the depths of 0.5—2 m from well lighted shallow sites and supplied to the laboratory within 15 minutes. Midparts of the thalli bearing no spores were used alone.

The intensity of photosynthetically active radiation (PhAR) falling on water surface during a day was measured with YANISHEVSKY piranometer and recorded with an EPP-09 recorder. Temperatures were measured three times a day at 8.00, 14.00 and 19.00.

The daily dynamics of visible and potential photosynthesis was studied on discs of 10—15 mm in diametre cut out of 10—20 thalli the day before the experiment. The discs were then arranged into averaged samples placed on a plastic net and covered with the same net, the gaps between being fused afterwards. A cassette thus prepared was provided with a pummet and submerged to the site from which the algae had originally been taken. The next day, separate samples were cut off the cassette from 7.00 to 18.00 at 2—3 hours' interval; the discs were put into special bottles and chambers for subsequent measurements of the visible and potential photosynthesis rates.

A series of special experiments has been carried out to compare the photosynthesis intensity and growth rates of whole thalli with those of the discs. The values obtained in both cases showed no differences which permits the application of the disc method to all the further experiments.

The rate of visible photosynthesis was estimated using the light bottles technique with the WINKLER's titration to measure the production of oxygen and calculated in mg of O_2 per 1 g of fresh weight. Moreover the rate of photosynthesis could be related to dry weight, thallus area and chlorophyll since it was shown that in July and August an *Ulva fenestrata* thallus of 100 mm^2 area weights 608 $\pm$ 23 mg and 163 $\pm$ 19 mg as dry and fresh respectively, and contains 0.560 $\pm$ 0.12 mg of chlorophyll.

Under optimal illumination, temperature and bicarbonate concentration the potential photosynthesis (VOZNESENSKY et al., 1965) was measured in a chamber with neutral light filters of different optical density. The illumination was successively decreased from 0.29 to 0.001 cal $\times$ cm^{-2} $\times$ min^{-2} while the temperature was maintained at about 21 °C throughout the experiment.

At three-hour intervals, the samples cut out from the cassette were placed into the chambers and kept there in the above conditions in a sea water flow for 20 minutes. After short adaptation to the new conditions, sea water enriched by bicarbonates was supplied to the chamber up to the optimal concentrations (5×10^{-3} M). In 20 min. the water was replaced with water enriched by radioactive bicarbonate of the same concentration. The sea water specific activity was 0.5 μ Cu $\times$ ml^{-1}. The sample exposed to light for 20 min was then fixed at 110 °C and dried out on foil under press. Radioactivity of the samples on the underlying

foil was detected with an automatic counter. The rate of photosynthesis was calculated according to pre-made tables in mg CO_2 per hour of exposition to light.

A spectrophotometer SF-14 was used to measure optical density of the samples during a day at an hour interval.

Pigments were extracted by an acetone ethanol mixture (3:1) to be transferred to ether. Chlorophyll concentrations were determined from the ether spectrophotometrically (SMITH and BENITES, 1955). Chromatographic paper was used to analyze yellow pigments according to the method developed by SAPOJNIKOV (1964). Pigment content during a day was determined on averaged samples prepared as described previously.

Chloroplast position was observed under a microscope with 10×40 multiplication of a thallus as seen perpendicularly. The distance between chloroplasts and an outer cell wall was measured with a microscope adjusting microscrew.

Results

The intensity of visible photosynthesis was measured during the summer months both on sunny and cloudy days. Figure 1 gives average values for visible photosynthesis and PhAR during August, including those obtained

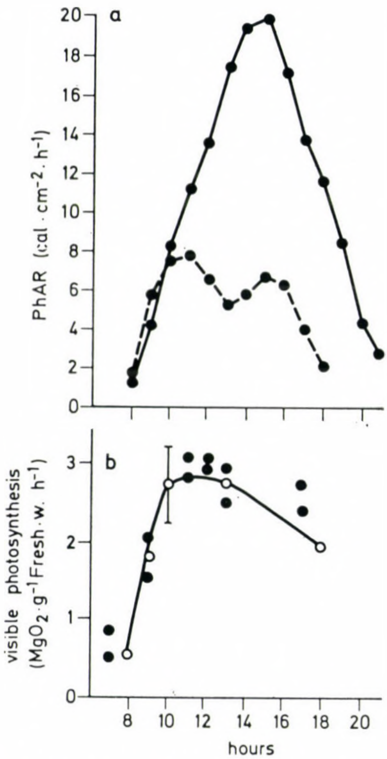

Fig. 1. Ulva fenestrata: Changes in the intensity of visible photosynthesis and in the energy of photosynthetically active radiation (PhAR) during August 1973. *A.* Solid line: for PhAR of an average August light day; dashed line for the PhAR on August 4, 1973; 154, 9 cal $\times$ cm^{-2} and 62 cal $\times$ cm^{-2} are the values for the total PhAR on an average light day (in August) and on August 4, 1973, respectively. *B.* Open circles for average values of visible photosynthesis measured during three bright and two dim days. Solid circles for the visible photosynthesis on August 4, 1973

for the dimmest day of the period. The mean curve of the changes of the visible photosynthesis rates during a day is of one-peaked nature. Photosynthesis was found to be maximal at 10.00 remained constant till 12.00—13.00 and gradually decreased by the evening. Maximum illumination on an August sunny day was recorded between 12.00—14.00.

The highest visible photosynthesis rate in August was 2—3.5 mg $O_2 \times g^{-1}$ fresh weight$\times h^{-1}$, or as expressed in terms of carbon acid approximately 2.7—4.8 mg $CO_2 \times g^{-1}$ fresh weight$\times h^{-1}$.

On dim days, the rates of visible photosynthesis differ little from the average monthly value; it decreases in the midday when the illumination drops to 5 cal$\times cm^{-2} \times h^{-1}$.

The lowest rate of potential photosynthesis was found in the earliest morning hours with the peak between 10.00 and 11.00 (Fig. 2). Potential

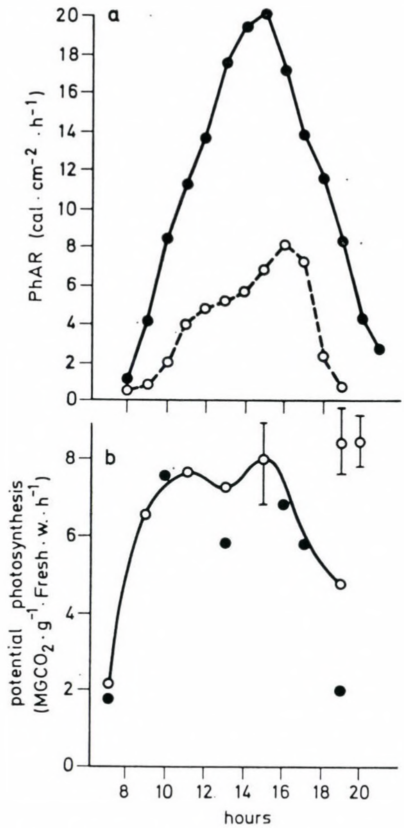

Fig. 2. Ulva fenestrata: Intesity of potential photosynthesis and energy of photosynthetically active radiation (PhAR) on water surface during August, 1973. *A.* Solid line for PhAR on average August light day; dashed line for PhAR on August 1, 1973. The total PhAR on August 1, 1973 is 48.9 cal$\times cm^{-2}$. *B.* Open circles for average values of potential photosynthesis measured during three dim days. Solid circles for potential photosynthesis values on August 1, 1973

photosynthesis was observed to decrease from 15.00 till 16.00. The mean monthly values for potential photosynthesis changes during a day showed in August an afternoon depression. Figure 2 presents a drop of the intensity of a noon potential photosynthesis. In this case the afternoon depression was observed under weak illumination that may suggest that inhibition of noon photosynthesis is unlikely to result from direct influence of the high light.

The comparison of the values of both visible and potential photosynthesis expressed in mg $CO_2 \times g^{-1}$ of fresh weight $\times h^{-1}$ shows that in the experimental conditions (closed bottles, motionless water) potential photosynthesis actually realizes no more than about 40% of the capacity determined in the above experiments.

In further studies of the *Ulva fenestrata* functional state during a day, we found a considerable change of the thallus optical density (Fig. 3). By 13.00—14.00 the optical density showed a 30—40% increase, in the range of the maximum absorption of light by chlorophyll *a* (680 nm) and 15—20% increase for the chlorophyll *b* maximum (654 nm). During afternoon hours the optical density dropped to its constant value. The measurements suggest a noon increase of chlorophyll content, especially that of chlorophyll *a*.

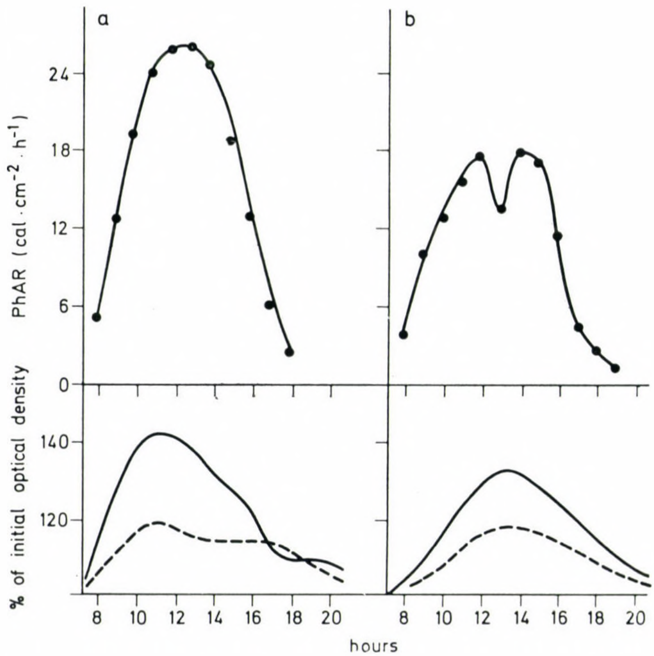

Fig. 3. Ulva fenestrata: thallus optical density and energy of photosynthetically active radiation (PhAR) on water surface. *A.* Values on October 17, 1975. Thick solid line is for PhAR; thin solid line is for thallus optical density with chlorophyll *a* maximum absorption (680 nm); dashed line for thallus optical density with chlorophyll *b* maximum absorption. *B.* Values on October 22, 1975; symbols as above

On one of the dim August days, 1974, main photosynthesis pigments of *Ulva fenestrata* were analyzed quantitatively to be compared with those from the green alga *Enteromorpha linza* (Fig. 4). Both algae species showed a midday chlorophyll increase, this being particularly high in *Enteromorpha linza*. Lutein content had a midday peak and an evening drop, while a violaxanthin content gave a reversed picture. A slight growth of carotene proportion was found in *Ulva fenestrata* during a day while *Enteromorpha linza* showed a noon increase with a subsequent evening fall.

The content of the main photosynthetic pigments was analyzed quantitatively to confirm the results of spectral measurements (Fig. 4). Carotenoid content was also found to vary during a day. Frequent rearrangements occur

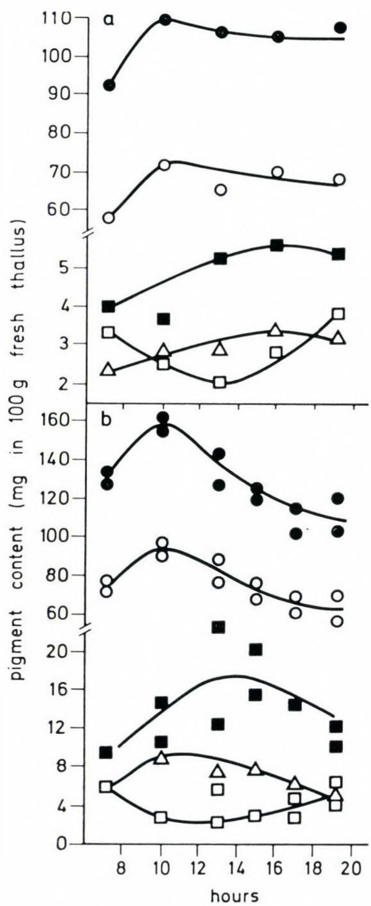

Fig. 4. Green algae *Ulva fenestrata* and *Enteromorpha linza*: pigment content in thalli during dim days. *A. Ulva fenestrata*, August 15, 1974. Solid circles for chlorophyll *a*; open circles for chlorophyll *b*; crosses for carotene; solid squares for luteine-zeaxanthine; open squares for violaxanthine. *B. Enteromorpha linza*, August 8, 1974; symbols as above

in the quantity of lutein and violaxanthin. The lutein content increased by noon dropping in the evening, while with violaxanthin we observed a reversed situation. Carotene showed an increased content in evenings. The above pigment content variations were observed on dim days when the total PhAR was 68 cal$\times$cm$^{-2}\times$h^{-1}.

In accordance with our previous works, the change in the chloroplast position in a cell from side towards a "cup" (Fig. 5) might give a considerable increase (by 20—30%) of the optical density of the *Ulva fenestrata* thalli (Titlyanov et al., 1975). In some higher plants, the chloroplast position is also known to considerably determine its physiological activity (Bogachova, 1969).

From the observations of chloroplast position during a day, we drew the conclusion that in summer months the chloroplast moved just from a side position near an inner cell wall to the side position near an outer cell wall and vice versa (Fig. 5). No "cup" position of the chloroplast was observed. Thus we concluded that it was only due to the variations of the pigment content that the above differences in the thallus optical density could occur. That was confirmed by the day pigment content of *Enteromorpha linza* which showed no changes of the chloroplast position.

Chloroplast dynamics in the cells of *Ulva fenestrata* is of particular interest (Fig. 6). Chloroplasts start moving from an inner cell wall towards an outer one as early as at night; by 10.00—12.00 most chloroplasts reach the outer cell wall to set for the backward motion in the afternoon hours. It should be especially noted that by 10.00—12.00, i.e. when a chloroplast is nearest to the environment, the intensity of both visible and potential photosynthesis appeared to be the highest, the pigment content being the largest.

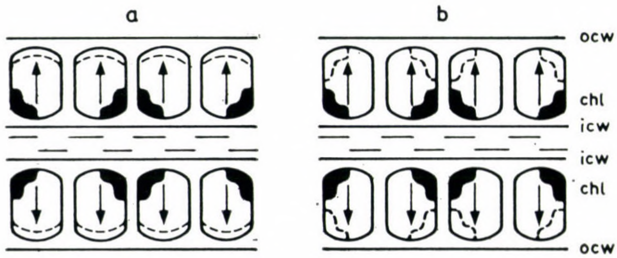

Fig. 5. Plot of possible changes of chloroplast position in *Ulva fenestrata* cells (thallus cross section); pointers showing the direction of the chloroplast migration. *A.* Chloroplast moving from an inner cell wall (ICW) from a "side" position towards an outer cell wall (OCW) in the "cup" position. *B.* Chloroplast moving from an inner cell wall ("side" position) towards an outer one without changing its "side" position

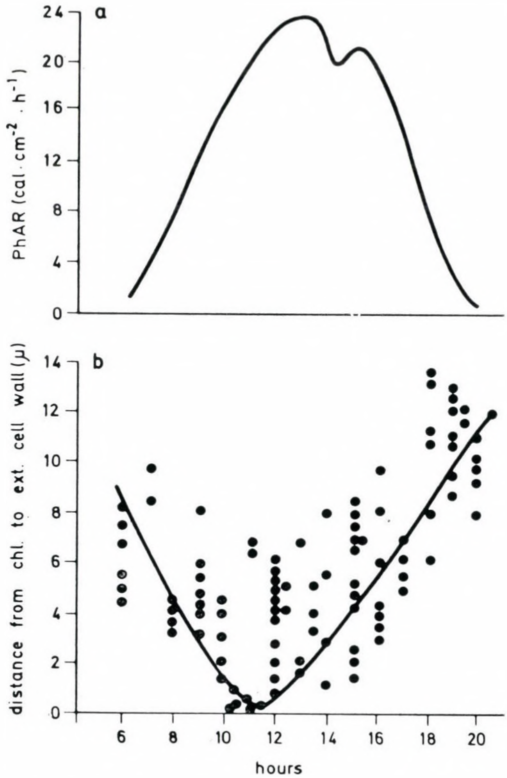

Fig. 6. Ulva fenestrata. Chloroplast day migration in cells and energy photosynthetically active radiation (PhAR) changing on July, 15, 1975. *A.* PhAR changes. *B.* Changing distance of chloroplast outer surface from the outer cell wall in microns. Solid circles for separate chloroplast positions in a cell

Discussion

Visible photosynthesis rates changing during a day present an integral indication of processes of carbon nutrition and catabolism affected by external and internal factors. In *Ulva fenestrata*, the curve of the daily fluctuations of visible photosynthesis rates has only one morning maximum at 10.00—11.00. Fresh water herbs *Elodea* and *Potamogeton* (GESSNER, 1938), *Ceratophyllum* (MEYER, 1939) as well as *Fucus vesiculosus*, a brown alga from the Barents Sea (TYCHOVSKAYA, 1960), and mixed macrophyte and phytoplankton populations (COPELAND and WHITWORTH, 1963) showed similar changes in visible photosynthesis rates. A morning maximum of photosynthesis was also observed in June for the fresh water milfoil *Myriophyllum spicatum* and its epiphyte the alga *Oedogonium* (MCCRACKEN, 1975).

Within first morning hours when the rates of visible photosynthesis are intensively growing *Ulva fenestrata* photosynthetic apparatus undergoes signif-

icant structure functional transformations preparing a maximal assimilation to the brightest period of a day. The thallus optical density increases at the chlorophyll absorption maxima.

Chlorophyll content grows along with changing ratio of carotenoid pigments. Thus growing potential capacities of the alga photosynthesis produce favourable conditions for full realization of the light absorbed.

The growth of the potential photosynthesis during morning hours may be associated with the KALVIN cycle enzyme synthesis induced by light. This way of carbonic acid assimilation is basic for the species of the genus *Ulva* (JOSHI and KAREKAR, 1973; TITLYANOV, unpublished materials). Synthesis of ribulosodiphosphate carboxylase possibly stimulated by light was reported by ZUCKER (1972) in his review on enzymes under light effect. The migration of chloroplasts from an inner to an outer cell wall may play a certain role in the morning increase of the photosynthetic potential in *Ulva fenestrata*.

Experiments made by ZURZYCKI (1955) and LECHOWSKI (1974) on higher plant leaves showed considerable changes of photosynthesis intensities with chloroplast migration which, however, produced small changes in the light absorption of leaves. In *Ulva fenestrata*, the migration of chloroplasts towards an outer cell wall resulted in no changes of light absorption. However, the rates of visible and potential photosynthesis were observed to rise simultaneously. Thus we may suggest a better supply of chloroplasts with carbonic acid and biogenic elements when they occur near an outer cell wall.

The question arises whether these daily structure-functional changes of the alga photosynthesis apparatus are controlled by environmental factors or they are determined by internal cycles. Internal rhythms in changing capacities of macroalga photosynthetic apparatus were reported by MING-DER SHYU et al. (1967). They showed experimentally the internal rhythms to be evolved as a response to certain rhythmic variations of light and dark periods in alga cultivation.

In *Ulva fenestrata*, the regulating role of the internal rhythms shows itself most distinctly in the determination of chloroplast migration. They start their motion towards an outer cell wall as early as in the night hours without light, to move on slowly even when the plants are fully darkened. A similar phenomenon was also observed in soy beans (BOGACHOVA, 1969). Bright light can hardly play any regulatory role in the process since changes in the pigment content of the *Ulva fenestrata* thalli occur both on bright and dim days. It is also true for the changes of potential photosynthesis rates whose noon depression was observed with the illumination to be even lower than that saturating photosynthesis.

Frequently observed noon photosynthesis depression is worthy of special note when different plants are compared as to their changes of photosynthesis rates during a day. It is most pronounced in terrestrial plants (MAXIMOV,

1958; MALKINA et al., 1970; CHERNYSHOV, 1975). This is most probably due to the factors produced by higher insolation which inhibits or stops natural preparation of the photosynthesic apparatus to maximal photosynthesis at the brighest period of a day. Overheating of leaves as well as insufficient water supply are the main harmful factors at this moment. The water medium excludes the extreme influence of the above factors on aquatic plants. However, inhibited noon photosynthesis is observed in phytoplankton and fresh water macrophytes (KURSANOV, 1933; NEWHOUS et al., 1967; FINENKO et al., 1971); this may be caused by direct light effect on enzyme and pigment systems of these plants.

It is most probable that light conditions during a day determine the rates of structure-functional changes rather than their direction. The transition of chloroplasts from an inner to an outer cell wall stimulated by light can present a good example (GLEBOVA and TITLYANOV, 1975) of such a case.

Reaching the peak, the *Ulva fenestrata* visible photosynthesis keeps its high rates until 18.00 despite the noon depression and decreased chlorophyll content in the evening. Thus we may assume that stable rates of visible photosynthesis may be accounted for by photosynthetic potentials of the alga which exceed their realization. Photosynthesis intensity in the afternoon falls due merely to a decreased illumination which drops by 15.00 down to the level saturating photosynthesis.

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CHEMOTAXONOMICAL PROOFS CONCERNING THE CLASSIFICATION OF *KICKXIA ELATINE* (L.) DUM. AND *KICKXIA SPURIA* (L.) DUM.

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The chemical composition of *Kickxia elatine* (L.) Dum. and of *K. spuria* (L.) Dum. was investigated. By inferences the taxonomical position of the genus and the stage of development reached during phylogenesis were established. The following conclusions were obtained:

— among the carbohydrates, in the *Kickxia* genus, too, mannitol and myo-inositol are present, characteristic for the family;

— among the iridoids, also in the species of *Kickxia*, antirrhinoside and linarioside are found, characteristic of *Antirrhineae* tribe;

— the characteristics distinguishing the *Kickxia* genus from the other genera of the tribe (*Linaria*, *Cymbalaria*, etc.) are the flavonoids: 5,6,7-trimethoxyflavone, and the two trihydroxy-dimethoxy—flavonglucoside.

Accordingly, the chemical characteristics testify, in conformity with the morphological characteristics, that *Kickxia* is one of the most developed genera within the family belonging to the *Antirrhineae* tribe.

The taxonomical division of the family *Scrophulariaceae* described by Wettstein (1891) on the basis of the work of Bentham and Hooker (1876) is basically accepted even in our own days. Wettstein (1891) divided the family into three subfamilies. He placed the genus *Kickxia* Dum.* et the beginning of the subfamily *Antirrhinoideae*, presumably among the less-developed species. The taxonomical distribution of the family was not considered by Wettstein (1935) himself to have been finally solved with regard the requirements of a natural system. This view is confirmed and supported also by Thieret (1967), who analysed in detail the taxonomical distribution of the family. Another kind of distribution of the family, known and accepted by many authors, was carried out by Pennell (1935) with regard to phylogenetical considerations. He placed the tribe *Antirrhineae* (within it the genus *Kickxia*) at the end of the subfamily *Scrophularioideae* (Pennell, 1964). This taxonomical classification — which is based on the position of the leaves, the extreme zygomorphy of the corolla, the strongly modified laceration of the capsule and on the complicated structure of the seeds that have become spe-

* It should not be confused with the genus *Kickxia* Blume = *Kibatalia* G. Don (*Apocynaceae*).

cialized — is fully agreed by THIERST and he emphasizes that the tribe *Antirrhineae* is one of most developed tribes in the family.

The systematization of the *Scrophulariaceae*, i.e. the setting of the categories within the family on a phylogenetical basis, was carried out first of all by using the morphological characteristics. Today, however, that it is well known the chemical properties and composition, and the biochemical processes taking place in the plant constitute a very important group of characters. The taxonomical importance of these characters has been recognized by many taxonomists. DE CANDOLLE (1804) was among the first who seriously examined the chemical and taxonomical interrelations. He pointed out that the plants which seem to be related on a morphological basis contain similar matters.

GRESHOFF (1891) in one of his papers writes: "man in the future will probably find the formula of chemical compounds in the plant taxonomical textbooks similarly as today we find the formula of flowers in them". In our century, mainly in the last decades, on the basis of the work of HEGNAUER (1962—1973), SWAIN (1963), HEYWOOD (1968), HARBORNE (1970), TÉTÉNYI (1970), the taxonomical importance of chemical characters has become undoubted. It is very important however to emphasize that taking into consideration chemical properties alone in systematization is a profound mistake (HEYWOOD, 1966).

According to HEGNAUER (1971), the following requirements should be fulfilled when using the chemical characters:

(1) The chemical structure of plant matters and their distribution in the flora should be exactly known.

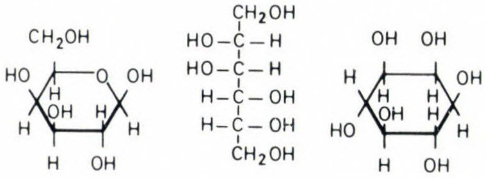
(2) The biosynthesis of the materials should be known.

(3) Further, the physiological and ecological function of the materials in the plants should be known.

The taxonomy of the family *Scrophulariaceae* raises several questions. The chemical properties seem to be usable for solving these questions. In the course of our work we wanted to clarify the place of the genus *Kickxia* by confirming or denying, on the basis of chemical characters, the results obtained by a thorough study of the morphological characters.

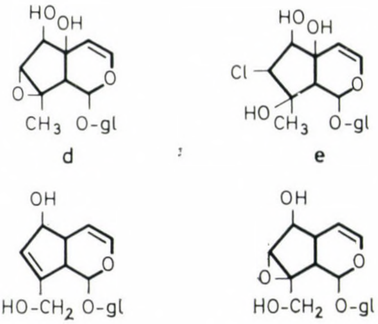
Since the chemical characters of the *Kickxia* species, the materials occuring in them, are hardly known yet, we investigated such compound groups whose one or several elements are to be found in most of the species of the family. Such elements are the carbohydrates. It is characteristic that the carbohydrates primarily stored in the form of sugar alcohol and oligosaccharides and not in the form of starch (HEGNAUER, 1973). Another group of materials the representatives of which were included in our investigations was that of iridoids. The third group was that of flavonoids which are wide-spread in the flora. Among them, the occurence of flavons belonging in the family *Scrophulariaceae* is characteristic (HARBORNE, 1966).

In *Kickxia elatine* (L.) Dum. we detected glucose (a), mannitol (b) and myo-inositol (c) among the carbohydrates (Tóth—Csordás—Pápay, 1978). The same were found in *Kickxia spuria* (L.) Dum. as well (Tóth—Kokovay—Bujtáss—Pápay, 1978). Mannitol, which is formed from fructose (Luckner, 1969) is wide-spread in the species of the family (Hegnauer, 1973), although, according to Steiner and Maas (1957), it does not occur in *Antirrhineae*, among others. This statement is however contradicted by the results also of Klobb and Fandre (1906), Zemplén (1937) and Kitagawa et al. (1973) who isolated mannitol from *Linaria* species.



a b c

It was only in the case of *Digitalis purpurea* that data on the occurence of myo-inositol in the plants of the family were reported (Raymakers, 1973). According to our investigations, however, it seems probable (Tóth—Lovász et al., 1978) as against the statements of Plouvier (1958) that myo-inositol, which comes from glucose, (Kindl—Hoffmann—Ostenhof, 1964) is very wide-spread in the family.



d ; e

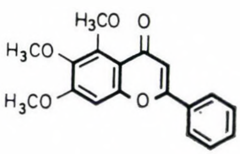
f g

Five of the iridoids, could be detected in both *Kickxia* species; two of them were isolated and identified as antirrhinoside(d) and linarioside(e) (Tóth—Csordás—Pápay, 1977; Tóth—Kokovay et al., 1977).

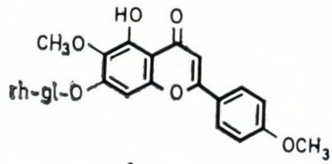
The iridoids are monoterpene derivatives, built up from acetate units through iridodial and 7-desoxyloganic acid (Inouye—Ueda—Takeda,

1970; Inouye, 1971). In the family *Scrophulariaceae*, aucubin (f) and catalpol (g) are the most wide-spread chemicals (Kooiman, 1970). They were not identified in *Kickxia* species. Antirrhinoside and linarioside, which were identified, are of a more complicated chemical structure.

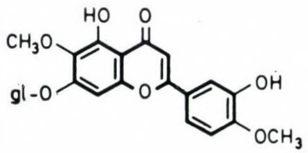
By testing the two *Kickxia* species for flavonoids, we were able to detect several materials four of which could be isolated and after determining their structure we found them to be 5,6,7-trimethoxyflavone (h), 5,7-dihydroxy-6,4'-dimethoxyflavone-7-0-rhamnoglucoside (pectolinarin) (i), 5,7,3'-trihydroxy-6,4'-dimethoxyflavone-7-0-glucoside (j) and 5,7,3'-trihydroxy-6,4'-dimethoxyflavone-7-0-rhamnoglucoside (k). We were the first to isolate the above materials



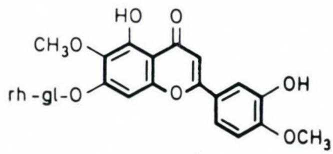
h



i

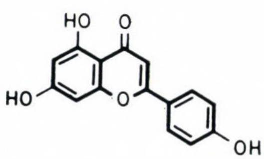


j

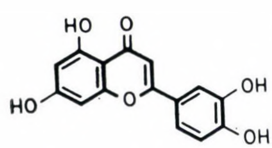


k

from the two plants (Tóth—Csordás—Pápay—Bujtás, 1976; Tóth Kokovay—Bujtás—Pápay, 1978). The latter two (j, k) hitherto have not been detected in any of the species of the family. The flavonoids are built up from a phenylpropane (C_6—C_3) part and one aromatic ring deriving from three acetate units (C_3) (Grisebach, 1962; Metzner, 1973). The flavones of the *Kickxia* species can be derived from apigenin (l) and luteolin (m), and considering their structure they belong to flavones of the most complicated structure (Hegnauer, 1973).



l



m

Let us now draw concusions from our results: in the two *Kickxia* species we proved the occurence of glucose, mannitol and myo-inositol. The occurrence

of glucose as a result of photosynthesis is not surprising. The occurence of mannitol in the family is general, although, according to STEINER and MAAS (1957), it cannot be found in certain tribes — like in *Antirrhineae* — of the family. Our results contested this statement. Even though mannitol does not occur in all the species of the family, it is more wide-spread than it was believed up to now. Myo-inositol has so far been isolated from one species of the family (RAYMAKERS, 1973). However, our researches seem to verify that it is significantly wide-spread in the family *Scrophulariaceae* since it does occur in the nine tribes examined by us out of the 15 tribes of the family. Thus, the occurrence of mannitol and myo-inositol is characteristic of the family in general, or of a significant part of the family.

In most of the species of the family iridoids can also be found (KOOIMAN, 1970). According to KOOIMAN's chromatographic examinations, the occurrence of antirrhinoside is characteristic of the species of *Antirrhineae*. Antirrhinoside isolated by us from the *Kickxia* species confirms this statement. Linarioside has so far been isolated only from *Linaria* species (KITAGAWA et al. 1972) and from *Cymbalaria muralis* (KAPOOR et al., 1974). From the fact that linarioside has been isolated by us also from *Kickxia* species, further, that KOOIMAN detected an *Antirrhinum* glycoside "B" — which is probably identical with linarioside — in several *Antirrhineae* species, a general occurrence of linarioside in *Antirrhineae* can be inferred. Thus, the occurrence of antirrhinoside and linarioside is probably a characteristic referring to *Antirrhineae*. From what has been said above it also follows that the genus *Kickxia* chemotaxonomically belongs to the tribe *Antirrhineae*; i.e., the chemical properties support the results obtained on the basis of morphological characteristics. Further, since antirhinoside and linarioside are of a more complicated character than the iridoids occuring in other tribes of the family *Scrophulariaceae*, even the conclusion can be drawn that the genus *Kickxia* is one of the most highly developed genera of the family. This conclusion is also in agreement with these drawn from the morphological characters.

The occurrence of flavons is characteristic of the family *Scrophulariaceae*. Pectolinarin (i) of the *Kickxia* species examined by us was isolated only from the *Linaria* species within the family (MERZ and WU, 1936; ZEMPLÉN, 1937; SMIRNOVA et al., 1974). This fact supports the view that the species of *Kickxia* and *Linaria* are closely related. Aurones occurring in the *Linaria* species (VALDÉS, 1970) cannot on the other hand be found according to our investigations either in the *Cymbalaria muralis* or in the *Kickxia* species. The 5,6,7-trimethoxyflavone (h) was isolated only by PINAR (1973) before us, from *Kickxia lanigera*. The further two flavoneglycosides isolated by us (j, k) have on the other hand not been isolated or detected in a single species of the family. Accordingly, the last three flavones are probably characteristic only of the *Kickxia* genus. They can be derived biogenetically from luteolin, but are of more complicated

structure than that. Their occurrence in the *Kickxia* species proves that these species have reached a high stage of development within the family during the evolution of the tribe. This inference is in agreement with that drawn by THIERET (1967) from morphological characters, according to which, the tribe *Antirrhineae* is one of the most developed tribes of the family. It is also clear from what has been said above that the occurrence or lack of the various flavonoids is such a characteristic from which conclusions can be drawn in relation to the genera.

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SHORT-TERM INVESTIGATIONS ON THE PHYTOPLANKTON OF LAKE BALATON AT TIHANY

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Between July 20 and August 18 1976, daily observations were carried out on the number and biomass of the phytoplankton of Lake Balaton, separately for micro- and macroalgae; in addition, organic carbon content, temperature and transparence of the water were measured. Comparable investigations on the Lake Balaton have not been made so far.

The dynamics of certain determined variables reflect the character of a large, extensive and shallow lake. The data presented here draw attention to the difference between the thirty day variations of macro- and microalgae, and point to the differences between information content of the mass variables (numbers and biomass). The organic carbon content, along with some other data, indicates the advanced state of eutrophication of the lake.

Introduction

Aims of the study were daily investigation of the number and biomass of the phytoplankton, taking macro- and microalgae separately into account (algae that do not exceed maximal length of 10 μm are considered to be microalgae and all above that size macroalgae), daily investigations of the particulate organic carbon content, Secchi-transparency and temperature of the water: by application of velocity of wind data for investigation period, an attempt to reveal functional, or at least correlational — stochastic relationships of the above — mentioned variables. Sampling and on-the-spot measurements took place between July 20 and August 18 1976, at Tihany, so data presented here should be considered more or less representative only for the area.

Daily variations of the number and biomass of the phytoplankton of Lake Balaton have not been studied so far but it is becoming of immense importance nowadays, mainly in connection with spatial-temporal structures of coexistential units. The presence and/or the population dynamics of certain component populations are considered in this sense. Apart from the theory, an obviously practical problem arises in connection with Lake Balaton, namely eutrophication. Eutrophication becomes apparent in the quantitative indices without any special interpretation. Besides environmental conservational points of view, eutrophication effects the above-mentioned categories

as well: to mention the former example, population dynamics may speed up and characteristic changes may be experienced in the qualitative and quantitative relationships of the component populations. From this aspect, this paper is in close connection with other quantitative investigations on feeding biology.

For the sake of completeness, special attention was paid to the qualitative and quantitative treatment of microalgae in the course of this work, since only estimates have so far been known (HERODEK and TAMÁS 1975).

Answer was sought to the question to what extent the quantity of organic carbon in the study period was determined by planktonic phytomass and whether the effects of weather conditions dominate in the formation of the organic carbon content of the water even in the production period of the producers. The question was the same in connection with SECCHI-transparency, that is, can primary product be characterized by SECCHI-transparency in spite of the peculiar properties of the Lake Balaton (ENTZ and SEBESTYÉN 1942; FELFÖLDY 1963). It is noted here that Lake Balaton with its average depth of 3.0—3.5 m cannot be called a typical lake, in spite of its open water surface of some 600 km^2 and the vertical stratification is not indicative of its classical form, but rather of special, "pannon-type" limnological processes (ENTZ and SEBESTYÉN 1942). A furthermore unsettled question was to what extent the temperature of the water affected the phytoplankton.

Material and methods

Five sampling points were located along the circumference of a circle around an open-water b7oy, situated 1200 m from the water front of the Tihany Institute. The circle was of a radius of 40 m and at all points water depths of 310 cm were measured. Water samples were taken daily over thirty days, always at the same time of the day, between 10 and 12 hours a.m. Samples, 1 liter in volume respectively, were taken from depths of 20 cm, 100 cm, 200 cm and 300 cm at the five sampling points. The total of 20 l of water collected in this way were then poured into a black plastic can and taken to the Institute. On six occasions, due to heavy storms, samples were taken from the same depths and from sampling points of the same distribution, but 400 m, and not 1200 m from the shore. These days were: July 24 and 25 August and 5, 6, 12 and 18 (Fig. 1).

Temperature of the water was measured at the buoy at depths of 40 cm, 90 cm and 160 cm, from which the mean was calculated (on the kind advice of Olga SEBESTYÉN). Water transparency was measured at the bouy as well, by the SECCHI-disc method.

The 20 of water collected daily was thoroughly stirred up after delivery and the particulate organic carbon content was determined from 100 ml quantities taken from this volume (OSTAPENYA 1965), using WHATMAN GF/C glass filter-papers for filtering. Results were expressed in mg $\cdot$ l^{-1}.

For the quantitative and qualitative study of microalgae RAZUMOV's method, originally described for bacterial research, was used (RAZUMOV 1932). This method has been used successfully in Hungary for bacterioplankton studies (OLÁH 1969, 1970, 1971, 1973), but some attempts to use this are known to have been made in microalgae studies (Pál JUHÁSZ-NAGY and Lajos VÖRÖS, personal communication). The authors membrane-filtering investigations started in 1975, the conclusions of which were used to alter some aspects of the originally described method. Difficulties arose from the fact that whereas preservation of the externa l morphology of the bacterium cell is not the primary aim in bacteriological studies, algologica l application requires the fixation of the systematically important external morphologica l

characters. The method entails drastic water abstraction, which results in a certain amount of deformation of the cell. In order to enhance identification the original method was altered as follows.

- 100 ml of the stirred up water (20 l) was taken to which 11 ml of 36—38% formalin was added as preservative and this mixture was filtered;
- the quantity of water filtered through the membranefilter (SARTORIUS-Membranfilter GMBH; pore diameter 0.2 μm) depended on the day's reading of SECCHI-transparency, compensating for the filling effect of the stirred up inorganic particles; in the investigation series, quantities of 10, 15, 20 and 40 ml were filtered;
- filtering was carried out in weak vacuum, taking 10—15 minutes for 10 ml of water to pass through;
- membrane-filters were dried at room temperature for 24 hours after filtering and then subjected to 20 minutes post-drying at 60 °C before staining with carbolerithrosin.

Macroalgae were examined with reversed planktonmicroscope (UTERMÖHL 1958).

In both study methods, the number (Number liter^{-1}) of each species was estimated from the size of the examined area, the filtered or the sedimented quantity of water and from the number of algae cells counted.

Biomass was calculated from the number and the volume of the algae species. Calculation of each algae species was done as follows:

1. In the case of those algae species, where the forms could not be likened to geometric bodies, volume — data derived from models were used (SEBESTYÉN 1954; TAMÁS 1955). Such species were: *Ceratium hirundinella*, *Pediastrum boryanum*, *Pediastrum duplex*, *Pediastrum simplex*.

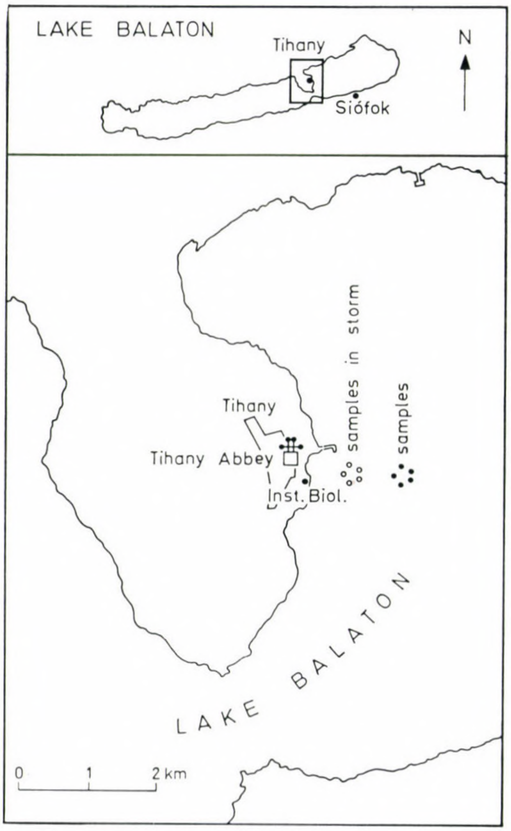

Fig. 1. Location of the sampling points

2. Volumes of filamentous algae were in all cases calculated on the basis of cylindrica models.

3. Volumes of other algae species were estimated from the geometrical body or bodies, to which the forms showed greatest resemblance. The mean sizes determined in the study were used and not the average of compiled data of the literature.

It is noted here that the volume of each alga species was calculated according to the common particle in Hungary, that is, without the possibly present mucilaginous sheath. Biomass values were calculated from the volumes by taking the specific gravity of the protoplasm to be 1.00, and finally expressing it in mg liter^{-1}.

Daily velocity of wind data, registered at the Meteorological Station of Siófok, were supplied by the National Institute of Meteorology. Daily average velocity of wind values were calculated by averaging readings taken at three hour intervals from 12 noon of the previous day to 12 noon of the given day.

Results and evaluation I.

With the two methods outlined above, 67 species, 7 varieties and 2 forms belonging to 57 genera were identified in thirty water samples (Table 1).

Exact numbers of genera, species, varieties and forms appear in Table 2, which also shows the two quantitative algological methods. It must be noted however that the two results are of different taxonomical value. Whilst application of UTERMÖHL's microscope with suitable preliminary studies yields taxonomically correct results, the membrane-filtering method, in most cases renders identification possible only to the genus with any reliability. In spite of all this, several factors necessitated the application of the latter method (it is sufficient to bring up one example, the large quantities of debris stirred up in storms).

In connection with quantitative results, the following remarks are necessary.

Table 1

Distribution of identified taxa in six taxonomical phyla

	Genus	Species	Varietas	Forma
Cyanophyta	9	9	1	1
	6 *Chroococcales*	6 *Chroococcales*		
	3 *Hormogonales*	3 *Hormogonales*	1 *Chroococcales*	1 *Chroococcales*
Euglenophyta	3	3	—	—
	3 *Euglenales*	3 *Euglenales*		
Chrysophyta	22	29	4	—
	1 *Xanthophyceae*	1 *Xanthophyceae*		
	1 *Chrysophyceae*	2 *Chrysophyceae*		
	20 *Bacillario-phyceae*	26 *Bacillario-phyceae*	4 *Bacillario-phyceae*	
Pyrrophyta	5	5	—	—
	3 *Cryptophyceae*	3 *Cryptophyceae*		
	2 *Dinophyceae*	2 *Dinophyceae*		
Chlorophyta	17	21	2	1
	15 *Chlorococcales*	17 *Chlorococcales*	1 *Chlorococcales*	1 *Chlorococcales*
	2 *Zygnematales*	4 *Zygnematales*	1 *Zygnematales*	
Caulobacteriales	1	1	—	—
	1 *Caulobacteriales*	1 *Caulobacteriales*		

Aphanisomenon flos-aquae f. *klebahni*, a permanent component of the summer phytoplankton of Lake Balaton was not found in any of the water samples between July 22 and 29. This phenomenon seems to be related to the fact that the investigation period was preceded by a stretch of unusually warm and dry weather, the effect of which could still be felt in the first few days.

Aphenisomenon issatschenkoi, not long ago described from the Lake Balaton, also occurred in our samples.

The category "Other *Chlorococcales*", demarcated by 3 μm—6 μm size interval, covers one form only, the phytomass of which is considerable in the less than 10 μm size group, and the specific identity of which apart from order, could not be determined.

Apart from the previous point, collective categories, such as "Other *Chlorococcales*" and "other species", contain unidentified species and small frowth forms of various algae species (autospores, zoospores etc.).

Due to the intensive character of the study, detailed information was obtained with regard to the temporal behaviour of each algal species, which can be fitted into five main types. Characteristic increase is shown in the abundance of *Peridinium inconspicum*, *Anabaena* sp. and *Aphanisomenonflos-aquae* f. *klebahni.*, of similar extent is shown by *Staurastrum paradoxum*, *Nitzschia acicularis* and *Dinobryon divergens*, *Criptomonas* sp. reaches a maximum in abundance at the middle of the study, whilst the temporal distribution of *Euglena acus* and *Euglena caudata*, in spite of their oscillating numbers, can be considered even. The picture thus obtained — although the taxonomical accuracy of this work does not render detailed analysis possible — justifies the assumption of a dynamics of algae association and of component populations. Figure 2 serving merely as an approach, shows the complete range of phytoplankton, where each line represents a formation, and a characteristic size distribution, with its dynamics, is apparent.

Wherever information was available, the biological indication of each trophic state was entered besides the taxon in Table 2, where ∗ ∗ ∗ indicates strongly eutrophic, ∗ ∗ stands for definitely eutrophic and ∗ means weakly eutrophic under Hungarian conditions (Uherkovich in Bartha et al. 1976, Pénzes 1976).

In connection with increasing eutrophication of the Lake, the not strictly algological observation should be noted that *Paraphysomonas vestita*, under certain conditions an indicator of eutrophic water, continually occurred in the samples and which has so far only been described in Lake Balaton (Hajdu 1975). It is an important fact with respect to the eutrophication process, since the sampling points were located in an area considered to be less eutrophic Herodek and Tamás 1976).

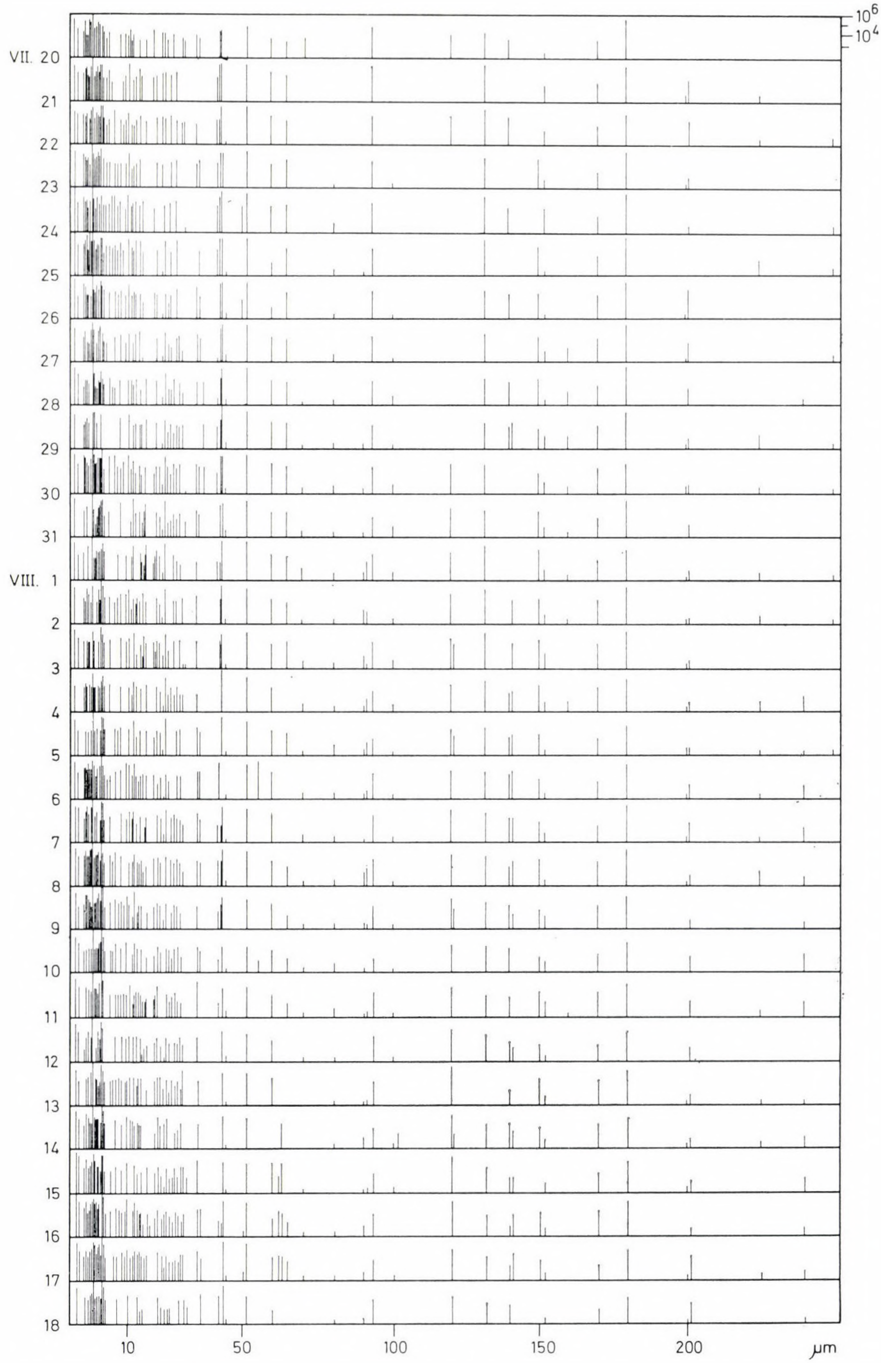

Fig. 2. The spectrum of numbers and sizes of algae in the study period

Table 2

Quantitative data on the phytoplankton of Lake Balaton in the study period

Date of collection: $I \cdot 10^3 \cdot l^{-1}$ = individuals · 1000 per litre

Species	July 20, 1976 $I \cdot 10^3 \cdot l^{-1}$	July 21, 1976 $I \cdot 10^3 \cdot l^{-1}$	July 22, 1976 $I \cdot 10^3 \cdot l^{-1}$	July 23, 1976 $I \cdot 10^3 \cdot l^{-1}$	July 24, 1976 $I \cdot 10^3 \cdot l^{-1}$	July 25, 1976 $I \cdot 10^3 \cdot l^{-1}$	July 26, 1976 $I \cdot 10^3 \cdot l^{-1}$	July 27, 1976 $I \cdot 10^3 \cdot l^{-1}$	July 28, 1976 $I \cdot 10^3 \cdot l^{-1}$	July 29, 1976 $I \cdot 10^3 \cdot l^{-1}$	July 30, 1976 $I \cdot 10^3 \cdot l^{-1}$	July 31, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 1, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 2, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 3, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 4, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 5, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 6, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 7, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 8, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 9, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 10, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 11, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 12, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 13, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 14, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 15, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 16, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 17, 1976 $I \cdot 10^3 \cdot l^{-1}$	August 18, 1976 $I \cdot 10^3 \cdot l^{-1}$
Cyanophyta																														
Chroococcales																														
1. *Aphanocapsa sp.*	26.66	8.88	8.88	8.88	50.63	17.77	53.32	8.88	17.77	17.77	71.09	302.15	177.73		188.46	47.38		53.32	71.09	53.32	177.73	17.77	17.77	17.77	35.54	17.77	17.77	124.41	17.77	17.77
2. *Chroococcus minutus* (Kuetz.) Naeg.	44.43	71.09	88.86	142.18	142.18	71.09	248.83	26.66	8.88	17.77	231.05	35.54	71.09	47.38	47.38	23.69		88.86	17.77	71.09	35.54	17.77		17.77		17.77	35.54	88.86	35.54	35.54
3. *C. minutus* (Kuetz.) Naeg. var. *obliteratus*												10.13	13.50						3.38				3.38					3.38		
4. *C. limneticus* Lemm.		8.88		35.54		17.77	17.77	17.77			35.54	35.54					23.69	53.32	17.77	17.77		17.77						35.54	17.77	35.54
5. *Chroococcus sp.*	88.86	71.09	79.98	71.09		71.09	17.77		88.86		71.09		35.54		71.09		23.69	35.54	124.41	71.09	17.77	71.09	71.09	71.09	17.77	71.09	231.05	124.41	53.32	
6. *Coelosphaerium kuetzigianum* Naeg.	13.50								30.38	6.75	6.75	10.13	20.25	10.13	20.25	2.53	6.75		43.88	10.13	13.50	20.25	10.13	6.75	6.75	5.06	18.40	15.90	6.75	
7. *C. naegelianum* Unger.													20.25		5.06															
8. *Coelosphaerium sp.*	8.88	17.77		17.77	8.88	17.77	17.77	8.88								47.38					8.88							17.77		
9. *Merismopedia glauca* (Ehr.) Naeg.		20.25		70.86														54.00	1.80			25.31	10.13					0.71		13.50
10. *Microcystis aeruginosa* Kuetz.	8.88	17.77	26.66	62.20	53.31	17.77	17.77	8.88	8.88		53.32		35.54			23.69	23.69	17.77	17.77	17.77	17.77				17.77	17.77	35.54	35.54	17.77	
Hormogonales																														
11. *Anabaena sp.*																														
12. *Aphanizomenon flos-aquae* (L.) Ralfs f. *klebahni* Elenkin										13.50	20.25	45.56	20.25	13.50 54.00	10.13 45.56	5.06 25.31	6.75 27.00	20.25 27.00	13.50 74.25	12.25 85.05	3.38 70.65	23.63	57.38	3.38 74.25	216.00	6.75 133.31	6.75 113.52	10.13 118.13	10.13 67.50	23.63
13. *A. issatschenkoi* (Uss.) Prosch.-Lavr.	13.50		60.75												10.13		6.75				6.75					3.38				
14. *Lyngbya circumcreta* G. S. West				40.50		81.00	13.50	20.25	13.50	6.75	6.75	10.13	33.75	27.00	10.13	5.06	6.75	6.75	6.75	16.20	6.75	3.38	10.13	3.38	13.50	5.06		16.88	6.75	
15. *L. limnetica* Lemm.	283.50	172.13	60.75	169.75	303.75	243.00	175.50	114.75	168.75	195.75	54.00	101.25	74.25	128.25	101.25	81.00	87.75	101.25	162.00	113.40	104.78	67.50	91.13	70.88	118.13	55.60	75.00	104.63	64.13	20.25
Euglenophyta																														
Euglenales																														
16. *Euglena acus* Ehr. 17. *E. caudata* Huebner	6.55	68.46	58.93	19.64	40.45	1.16	1.07	13.50	20.25	27.00	50.63	10.13	20.25	30.38	10.13	15.19	20.25	33.80	50.63	16.20	20.25	13.50	8.44	8.44	42.19	58.22	6.13	11.80	3.34	
18. *E. tripteris* (Duj.) Klebs	0.20	2.30	1.80	0.60	1.30	0.10	0.10	1.30	0.30	1.60	0.90	0.70	0.80	0.80	1.40	0.80	0.40	0.10	0.70	0.10	1.40	0.60	2.10	0.40	0.60	0.60	0.80	0.70	0.40	0.20
19. *Euglena sp.*	26.66	17.77	26.66	35.54	17.77	53.30	71.09	88.86	364.35	53.30	177.73	248.83	213.28	260.61	71.09		47.38	166.60	124.41	408.79	106.64	71.09	142.18	142.18	159.96	35.54	177.77	266.60	213.28	35.54
20. *Lepocinclis sp.*																										5.06				
21. *Phacus sp.*	16.86	40.50	40.50	10.13		0.20	0.20	0.30	0.70	0.60	0.60	0.50	0.50	0.70	10.13	5.06	0.30	0.10	0.90	0.50	0.80	0.20	0.40	0.20	4.00	15.19	0.20	3.38	3.38	3.38
Chrysophyta																														
Xanthophyceae																														
22. *Planctonema lauterborni* Schmidle		10.13	10.13	0.40	0.20	20.25	6.75	6.75	0.90	0.20	0.30	0.10	0.50	0.30	0.30	0.50	0.30	1.30	1.70	0.50	0.90	2.10	1.60	1.20	0.60	0.40	0.80	0.40	12.13	6.75
Chrysophyceae																														
23. *Dinobryon divergens* Imh.	13.50	239.90	20.25	222.75	182.25	324.00	162.00	155.25	47.25	67.50	229.50	86.06	6.75	13.50	45.56		6.75		6.75	12.25	47.25							3.38		
24. *D. sertularia* Ehr.	162.00		81.00	10.13			94.50	40.50	13.50		40.50	212.63	6.75	47.25	30.38	40.50	47.25	60.75	60.75	16.20	16.87	23.63	151.88	16.88	10.13	106.31	76.60	59.06	61.00	
Bacillariophyceae																														
25. *Amphora ovalis* Kuetz.													6.75	10.13		20.25	13.50	13.50	16.88	20.25	13.50	13.50	3.38	6.75	13.50	5.06	3.38	10.13	6.75	13.50
26. *Attheya zachariasi* J. Brun																														
27. *Campylodiscus sp.*		70.88	10.13	60.75	81.00	202.50	6.75	43.88		13.50	20.25	5.06					6.75									15.19	53.70	35.44	20.25	
28. *Cyclotella comta* (Ehr.) Kuetz.											13.5	7.60	20.25	6.75	15.19	7.59	20.25	13.50	13.50	14.80	13.50	10.13	16.88	6.75	16.88	15.19	33.75	6.75	20.25	3.38
29. *C. glomerata* Bachm. 30. *C. quadriiuncta* Schroeter	6.75	91.13	50.63	40.50	40.50	162.00	2.025	74.25	6.75	27.00	33.75	20.25	40.50	20.25	12.66	10.13	33.75	20.25	23.63	20.25	27.04	10.13	15.19	27.00	20.25	20.25	9.20	20.25	25.31	3.38
31. *C. ocellata* Pant.	533.20	462.11	426.56	719.82	355.47	391.01	497.66	133.30	159.96	124.41	266.60	159.96	106.64	47.38		71.09		408.79	266.60	302.15	319.92	88.86	142.18	88.86	88.86	53.32	177.77	444.33	231.06	88.86
32. *Cyclotella sp.*	35.54	97.75	23.79	23.79	53.32	53.32	35.54		53.32		195.50	35.54		47.38	47.38			17.77	35.54	88.86	53.31	17.77	17.77	17.77	17.77		53.32	177.77	88.86	35.54
33. *Cymatopleura elliptica* (Bréb.) W. Smith		0.60		0.10			0.20	0.10		0.30	0.30		0.10	0.10	0.10	0.10	0.40	0.10	0.10	0.20	0.10				0.10	0.10	0.20		0.20	0.10
34. *C. solea* (Bréb.) W. Smith			0.20		0.20	0.60		0.10		0.10	0.10		0.10	0.10			0.10								0.10			0.30		
35. *Cymbella prostrata* (Berk.) Cleve																														10.13
36. *Cocconeis sp.*		8.88			177.73	53.32			8.88											35.54		17.77			17.77				17.77	
37. *Diatoma vulgare* Bory					20.25		6.75																					0.10	0.70	0.10
38. *Diploneis puella* (Schum.) Cleve	50.63	10.13			10.13		20.25				6.75		6.75	20.25		5.06	6.75		20.25		6.75		3.38	3.38	3.38	10.13	3.00	6.75	6.75	
39. *Diploneis sp.*	8.88	17.77	8.88	26.66	35.54	53.32		8.88										8.88												
40. *Epithemia sorex* Kuetz.		20.25			81.00	20.25	6.75					5.06	3.38	0.10				13.50		2.03				3.38						
41. *Fragilaria construens* (Ehr.) Grun.	10.13		10.13					1.00	1.80	27.00				40.50		5.06			6.75	4.05				6.75	131.63		12.30	10.13	27.00	10.13
42. *Gyrosigma distortum* (W. Smith) Cleve var. *parkeri* Harris 43. *G. kuetzingii* (Grun.) Cleve						0.20	0.10			0.20	0.30	0.20	0.70	4.80	1.00	0.40	0.40	0.40	0.10	2.80	0.40	0.20	0.30	0.30	0.30	0.90	0.10	0.70	0.70	0.10
44. *G. prolongatum* (W. Smith) Cleve													6.75	3.70	0.10	1.40	1.30	0.70		3.20	0.10		0.10		0.20		0.10			0.10
45. *Gomphonema sp.*					159.96	53.32	35.54	26.66	8.88		71.09						23.63			17.77							17.77	17.77	17.77	17.77
46. *Melosira granulata* (Ehr.) Ralfs	0.10	0.30	0.10	1.30	1.60	1.70	2.30	1.70	3.10	1.50	2.70	1.20	1.00	2.00	1.80	1.60	1.20	1.10	0.60	0.80	0.90	0.50	0.10	0.20	0.10	0.10	0.20	0.30	0.40	0.60
47. *Navicula cryptocephala* Kuetz.		20.25	70.88	20.25	60.75	20.25	13.50	3.38	3.38	13.50	6.75	5.06				10.13			13.50	26.33	6.75	3.38	6.75	3.38	16.88		3.38	3.38	6.75	
48. *N. gracilis* Ehr.													6.75		5.06															
49. *N. hungarica* Grun. var. *capitata* (Ehr.) Cleve																	13.50				6.75									
51. *Nitzschia acicularis* W. Smith**	74.25	243.00	445.50	293.63	364.50	324.00	303.75	337.50	351.00	472.50	330.75	227.81	472.50	219.38	293.63	111.38	108.00	162.00	101.25	166.05	81.18	48.93	73.31	77.63	94.50	81.00	55.20	119.80	135.00	40.50
52. *N. closterium* (Ehr.) W. Smith**	6.75	30.38	10.13	30.38	40.50	40.50	20.25	13.50	13.50	27.00	20.25	10.13	20.25	13.50	20.25		10.13			6.08	3.38	3.38	1.69					3.38	6.75	
53. *N. tryblionella* Hantzsch var. *victoriae* Grun.**										13.50	13.50																			
54. *N. amphibia* Grun.** 55. *N. sigmoidea* (Ehr.) W. Smith** 56. *N. subrostrata* Hust.**	67.50	344.25	425.25	293.63	648.00	324.00	330.75	391.50	280.13	945.00	259.88	263.25	587.25	459.00	283.50	415.00	405.00	337.75	273.38	147.83	91.20	40.50	64.13	70.88	87.75	88.59	55.20	113.38	141.78	212.63
57. *Nitzschia sp.***	17.77	124.41	71.09	213.28	213.28	177.73	142.18	444.30	35.54	124.41	177.73	106.64	35.54	118.46	94.76	23.69	23.69	106.64	17.77	17.77	17.77		71.09	35.54	35.54	53.32			17.77	
58. *Rhizosolenia eriensis* H. L. Smith																											3.38	16.90	10.13	
59. *Rhoicosphaenia curvata* (Kuetz.) Grun.	6.75	10.13		0.20							0.10	5.06			0.10												3.38			3.38
60. *Surirella robusta* Ehr. var. *splendida* (Ehr.) V. Heurck		0.50	0.10			1.40				1.10	0.10		0.30	0.60		0.60	0.10	0.10	0.20	1.30			0.30		0.10	0.20			0.20	
61. *Synedra acus* Kuetz. var. *angustissima* Grun.	13.50	141.75	101.25	50.63	121.50	182.00	47.25	47.25	33.75	13.50	43.88	27.84	138.38	121.50	106.31	73.41	60.75	54.00	67.50	72.90	23.66	25.30	8.44	25.30	13.50	15.19	12.30	13.50	155.25	6.75
62. *Tabellaria sp.*	40.50																													
Pyrrophyta																														
Cryptophyceae																														
63. *Chroomonas sp.*	17.77			71.09		35.54	35.54				35.54	35.54									17.77						17.77	35.54		
64. *Cryptomonas caudata* Schiller 65. *C. erosa* Ehr. 66. *C. ovata* Ehr.	23.63	50.63	30.38		20.25	101.00	13.50	67.75	97.88	60.75	131.63	137.81	202.50	131.63	167.00	136.69	138.38	30.38	101.25	74.93	47.32	33.75	27.00	18.56	13.50	58.22	15.34	18.55	16.88	3.38
67. *Rhodomonas sp.* 3 µm–6 µm	231.06	479.92	426.55	542.07	746.47	728.70	639.84	497.62	1146.38	1084.17	1564.06	1137.50	213.27	1469.14	734.44	142.14	521.22	1240.81	853.12	2346.10	2435.47	1066.40	2328.33	693.16	853.13	1297.46	515.42	1297.45	977.54	888.65
68. *Rhodomonas sp.* 6 µm–10 µm		ia	106.64	35.54		17.77	17.77				195.54			23.69				53.32		195.50	71.09	71.09	17.77	35.54	17.77	53.32	35.54	17.77	17.77	17.77
Dynophyceae																														
69. *Ceratium hirundinella* (O. F. Mueller) Schrank	4.70	5.80	5.30	5.90	2.00	7.40	14.90	14.30	7.60	10.00	19.00	8.40	7.00	22.00	13.00	10.40	6.80	3.40	3.50	11.50	11.90	5.00	10.20	5.30	12.80	10.40	6.40	16.30	7.20	1.20
70. *Peridinium inconspicuum* Lemm.		10.13	60.75	20.25		20.25	20.25	13.50	20.25	20.25	33.75	15.19	70.88	23.63	30.38	20.25	30.38	6.75	47.25	34.43	28.73	38.81	67.50	18.56	52.32	88.60	35.30	40.50	54.00	15.00
Chlorophyta																														
Chlorococcales																														
71. *Actinastrum hantzschii* Lagerh.**								0.30		20.25	6.75		5.06	0.10	2.53								3.38	3.38				3.38		
72. *Ankistrodesmus angustus* Bern**	6.75		10.13						40.50	47.25	20.25	25.31	20.25	13.50	20.25	15.19	13.50	13.50	20.25	8.10	6.75	3.38	5.06	3.38	3.38		10.74	10.13	23.63	
73. *Chodatella balatonica* Scherf.	97.75	60.26	88.86	97.75	142.18	71.09	106.64	8.88	8.88	35.54	71.09	88.86	71.09	23.69			23.62	88.86	71.09	71.09	71.09	35.54	17.77	53.32	35.54	35.54	35.54	53.32	71.09	
74. *Coelastrum reticulatum* (Dang.) Senn														27.00			40.50	6.75		12.15	18.56		13.50	3.38	13.50	10.13		10.13	37.13	3.38
75. *Crucigenia tetrapedia* (Kirchn.) W. et G. S. West							13.50	118.25	33.75	27.00	81.00	40.50	27.00		5.06	10.13	20.25	13.50	54.00	28.35	30.38	16.88	3.38	6.75	33.75	6.05	15.34	30.38	12.12	
76. *Crucigenis sp.*	35.54	17.77	23.62	35.54	35.54	17.77	35.54	8.88	8.88		53.32	17.77	35.54	23.69	23.69	23.69	23.69	17.77	17.77	17.77	17.77	17.77			17.77	35.54	17.77	17.77	17.77	17.77
77. *Dictyosphaerium pulchellum* Wood*	6.75																													
78. *Elakatothrix lacustris* Korsch.		20.25	30.38	20.25	40.50	40.50		0.20	0.60	10.13	6.75		6.75						6.75	2.03	6.75	3.38	3.38		6.75			3.38		13.50
79. *Micractinium pusillum* Fresen.	10.13																													
80. *Oocystis sp.* 3 µm–6 µm	88.86	17.77	44.43	53.32	17.77	35.54	35.54		8.88		53.32	17.77	35.54					17.77		88.86	53.32	53.32	71.09	17.77	35.54	71.09	35.54	231.05	53.32	53.32
81. *Oocystis sp.* 6 µm–10 µm	23.79	23.79	23.79	23.79	17.77		17.77	8.88					35.54	71.09	43.84			159.95	17.77		142.18	71.09	35.54	35.54	35.54	88.86	142.78	226.64	71.09	53.32
82. *Oocystis* sp. 10 µm—	20.25		10.13				13.50	47.25	10.13	40.50	11.81	13.92	72.50	26.69	45.50	39.24	20.25	40.50	45.56	24.30	40.50	37.97	39.66	50.63	21.09	39.25	26.08	57.38	32.06	16.03
83. *Pediastrum boryanum* (Turp.) Menegh.			0.10			0.20	0.50	0.80	0.50	0.50	0.20	0.50		0.30	0.20		0.10	0.10	0.30	0.20		0.30	0.50	0.10	0.20	0.10	0.10		0.10	0.20
84. *P. duplex* Meyen***									0.10	0.10	0.10	0.20	0.70	0.20	0.50	0.60	0.10	0.40	0.60	0.40	0.30	0.30	0.20	0.10			0.10	0.10	0.10	
85. *P. simplex* (Meyen) Lemm.				0.10			0.10	0.20	0.80	0.20	0.55	0.90	0.40	0.30	0.65	0.50	0.10	0.20	0.30	0.20	0.20	0.10	0.10	0.10		0.10	0.20		0.20	
86. *Selenastrum sp.*	248.82	26.66	17.77	8.88		142.18		17.77	17.77	35.54	35.54				47.38	47.38		53.31		142.18	35.54					35.54	88.86	142.18	53.32	71.09
87. *Scenedesmus acuminatus* (Lagerh.) Chop.**												5.06																		
88. *S. arcuatus* Meyen f. *aherkovichi*																		6.75												
89. *S. balatonicus* Hortob.			0.10	0.10	0.70	0.25	0.10	0.60	0.25	0.40	0.50	0.15	0.60	0.40	0.10	0.30	0.75	0.50	0.40	0.30	0.40	0.80	0.45	0.10	0.20	0.30		0.20	0.10	0.10
90. *S. ecornis* (Ralfs.) Chop.*																		6.75	10.13	4.05										
91. *S. quadricauda* (Turd.) Bréb.		20.25	20.25	20.25	60.75	141.80	10.13	47.25	33.75	23.63	6.75	15.19		13.50	15.19	25.31	6.75	20.25	6.75	10.13	5.06	13.50	16.88	33.75	6.75	15.19	6.75	13.50	23.63	20.25
92. *Scenedesmus sp.* 1.5 µm–3 µm	222.16	97.75	44.43	79.98	71.09	106.64	88.86	88.86	44.43	34.43	106.63			23.69		47.38	23.69	88.86	71.09	177.77	177.77	17.77	71.09	35.54	35.54	106.84	88.86	248.83	53.32	
93. *Scenedesmus sp.* 3 µm–6 µm	168.84	168.84	71.09	142.18		71.09	71.09	71.09	26.65		106.63	71.09	71.09	118.46	47.38	47.38		106.64		142.18	195.50	71.09	106.64	71.09	8.86	53.32	35.54	159.96	195.50	53.32
94. *Scenedesmus sp.* 6 µm–10 µm				17.77	35.54	35.54	17.77				35.54		35.54	47.38			23.69				35.54		17.77		17.77		17.77	35.54		
95. *Schroederia robusta* Kors.								20.25	13.50	13.50	43.88	18.19	3.38		37.97	5.06	27.00	20.25	13.50	12.15	6.75	8.44	3.38	25.31	3.38	15.20	18.40	3.38	16.90	
96. *Tetraedron sp.* 3 µm–6 µm	133.30	275.79	142.18	17.77	88.86	106.64	17.77	17.77			106.64	88.86	35.54	23.69	23.62	71.09	47.38	124.41	177.73	266.60	17.77	35.54	35.54	17.77	88.86	35.54	71.09	231.05	88.86	35.54
97. *Tetraedron sp.* 6 µm–10 µm			8.88	8.88	35.54	35.54	17.77											35.54	17.77							17.77		35.54		
98. *Tetrastrum glabrum* Lemm.	6.75					40.50			20.25		12.13	3.80	16.88	6.75		5.06		6.75	18.56	16.20	3.38	6.75	3.38			5.06		13.50	16.80	
99. *T. hastiferum* (Arn.) Korsch.	6.75																													
100. *T. staurogeniaeforme* (Schroed.) Lemm.	6.75						6.75	6.75	6.75	6.75	13.50	5.06			5.06	5.06		6.75					3.38	6.75	3.38		3.38	10.13	6.75	3.38
101. *Tetrastrum sp.*	71.09	53.32	44.43	71.09	53.32	17.77	71.09	8.88	17.77		195.50	17.77	71.09	23.69	23.69	23.69	23.69	35.54	17.77	17.77	17.77	17.77		17.77	17.77	35.54	17.77	17.77	17.77	17.77
102. *Other Chlorococcales* 1.5 µm–3 µm	17.77	35.54	97.75	88.86	35.54	35.54	17.77	8.88	35.54		53.32	17.77	142.18	71.09	47.38		23.69	177.77	53.37	88.86	71.09	35.05	53.32	88.86	53.32	71.09	35.54	53.32	53.32	53.32
103. *Other Chlorococcales* 3 µm–6 µm	97.75	124.44	204.39	533.32	231.05	266.60	124.41	53.32	53.32		944.22	248.83	497.66	450.15	136.61	118.46	473.84	1137.50	639.84	1190.82	817.57	355.47	319.92	195.50	177.73	426.56	284.34	479.87	426.56	213.28
104. *Other Chlorococcales* 6 µm–10 µm				8.88	53.32	35.54			8.88	35.54	53.32	53.32	71.09	47.38		142.15				53.32	35.54	35.54	88.86	17.77		17.77	17.77	52.41	35.54	17.77
Zygnematales																														
105. *Closterium acutum* Bréb.								2.03	2.03	1.35	0.20	0.30	0.30	0.30		0.60							0.10	0.10	0.20					
106. *C. acutum* Bréb. var. *variabile* (Lemm.) Meyen	6.75		3.38		20.25		23.63		16.75	13.50						5.06	6.75	13.50	23.63	6.75	11.81	10.13	5.90	3.38	3.38	20.25	3.38	1.69	12.13	6.75
107. *C. aciculare* West									0.30							1.70	0.30	1.00	1.40	0.60	.050	1.50	1.70	0.60	0.10	1.00	1.30	0.80	0.60	0.10
108. *Staurastrum paradoxum* Meyen	74.25	101.25	60.75	30.38	60.75	20.25	40.50	20.25	20.25	13.50	16.88	7.60	20.25		12.66	7.59	3.38	20.25	33.75	40.50	13.50	3.38	16.88	10.13	6.75	7.59	12.30	6.75	10.13	
109. *Staurastrum sp.*	44.43	71.09	53.32	26.66	35.54	106.64	53.32		8.88		88.86			118.46	47.38	71.09		177.77	53.32	71.09	35.54	35.54	17.77		17.77	17.77	35.54	17.77	35.54	
110. *Other species*	1377.45	906.45	1013.09	382.13	924.22	1101.96	693.16	346.57	790.92	177.79	2061.73	1279.69	550.96	521.22	497.53	497.53	94.76	1688.48	1901.77	3021.50	2683.81	1919.54	1670.71	1706.26	1688.48	2026.48	2328.33	4638.90	2897.09	1084.18
Caulobacteriales																														
111. *Planctomyces bekefii* Gimesi	479.88	319.92	266.60	382.13	1200.86	1119.73	870.90	355.47	542.09	266.60	550.98	515.43	639.84	284.30	450.15	47.38	379.07	408.79	248.83	558.75	408.79	302.14	497.66	586.52	213.28	426.56	710.94	1033.01	444.33	142.18

Results and evaluation II.

To describe spatial-temporal structures of producers, various algological studies employ numbers or phytomass, depending on the nature of the study. It nearly counts as an exception to use both. The two approaches on no account can be taken as equal as it is apparent when considering their qualitative differences. The quantitative algological results of this study show the latter conclusion.

The mean value of the total number in the study period is high, $60.41 \cdot \cdot 10^5$ $I \cdot l^{-1}$ (where $I \cdot l^{-1}$ = number $\cdot$ l^{-1}). Daily readings fluctuated, showing increasing and decreasing tendencies in alternating two-three day periods. For the study period as a whole, the total number tended to increase. Viewing the number of microalgae separately, although this is considered to be the results of a preliminary investigation, the high mean value of $47.67 \cdot 10^5 \cdot \cdot I \cdot l^{-1}$ is pointed out, which is the first and at the same time rather high actual value of this order from Lake Balaton. To dispell suspicion of bacterioplankton, which the applied method would justify, the variety of form microalga should be noted; 42 different forms could be allocated to 21 genera (also see Table 3 and Fig. 2). The mean of $I \cdot l^{-1}$ of microalgae, $12 \cdot 76 \cdot 10^5$, corresponds with results of previous studies of the Lake (HERODEK and TAMÁS 1973; TAMÁS 1969, 1973).

Distributions of phytomass and numbers in various taxonomical phyla appear in Fig. 3, both according to size interval and totals. The areas of circle diagrams are proportional to the thirty days mean of the given variable.

The phytomass of *Caulobacteriales* is negligible with respect to macroalgae phytomass as well as total phytomass.

The thirty days' mean of planktonic phytomass is 1.99 mg $\cdot$ l^{-1}, from this microalgae account for 0.28 mg $\cdot$ l^{-1}, whilst macroalgae make up for 1.71 mg $\cdot$ l^{-1}, with large fluctuations of readings as well.

It could be further be inferred that the phytomass of microalgae showed increasing, and the phytomass of macroalgae showed decreasing tendencies (Fig. 4) and the circle diagrams clearly illustrate that the distribution of total numbers was to a certain extent determined by the microalgae and the total phytomass was determined by macroalgae. Subsequently, the monthly feature of numbers is rather like microalgae, whereas the feature of total phytomass is like macroalgae. This inference is valid for relationships with other factors as well (Fig. 6, Table 3).

The above are accounted for by the facts that in the study period microalgae made up for 79% of total numbers whilst for only 14% of the total phytomass (this 14% is more than what had previously been persumed and in view of production and feeding biology it could be important).

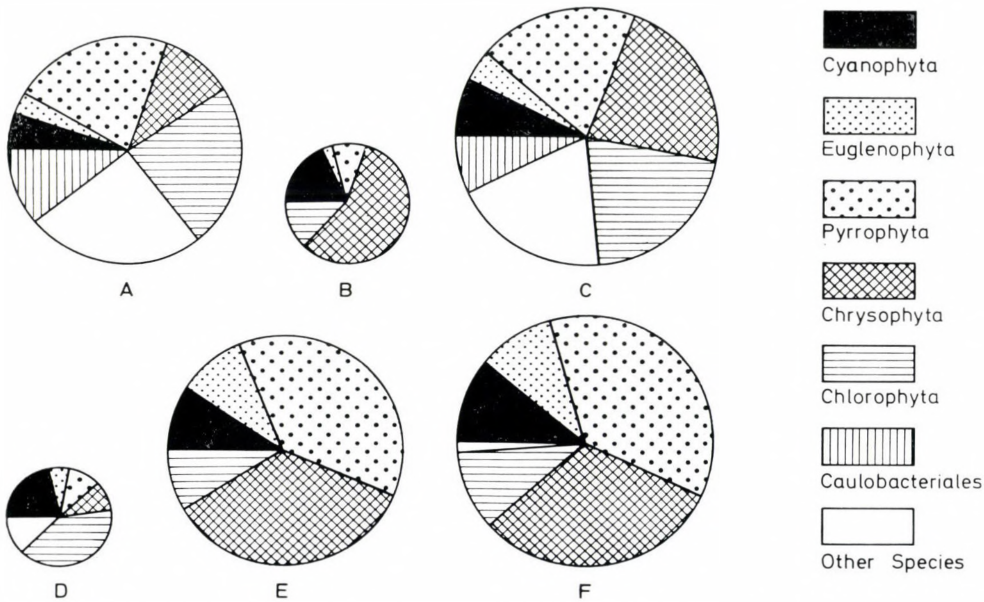

Fig. 3. Distributions of mean of thirty days' data of numbers and phytomass in each taxonomical phyla. A. microalgae $I \cdot l^{-1}$; B. phytomass of microalgae; C. macroalgae $I \cdot l^{-1}$; D. phytomass of macroalgae; E. total $I \cdot l^{-1}$; F. total phytomass

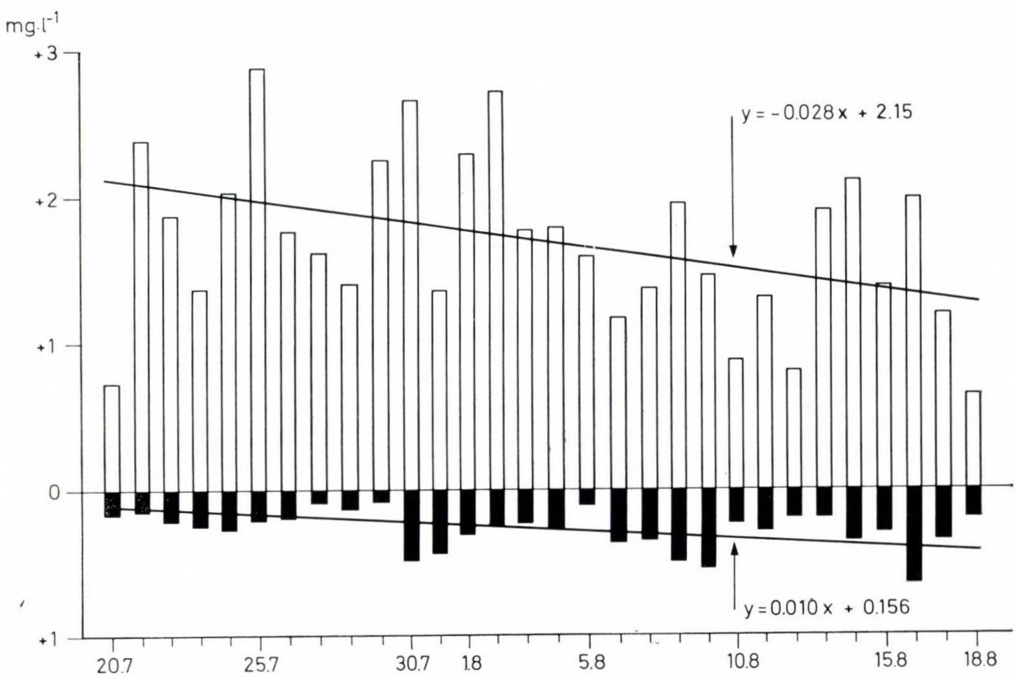

Fig. 4. Histogram of biomass of macroalgae (light) and microalgae (dark)

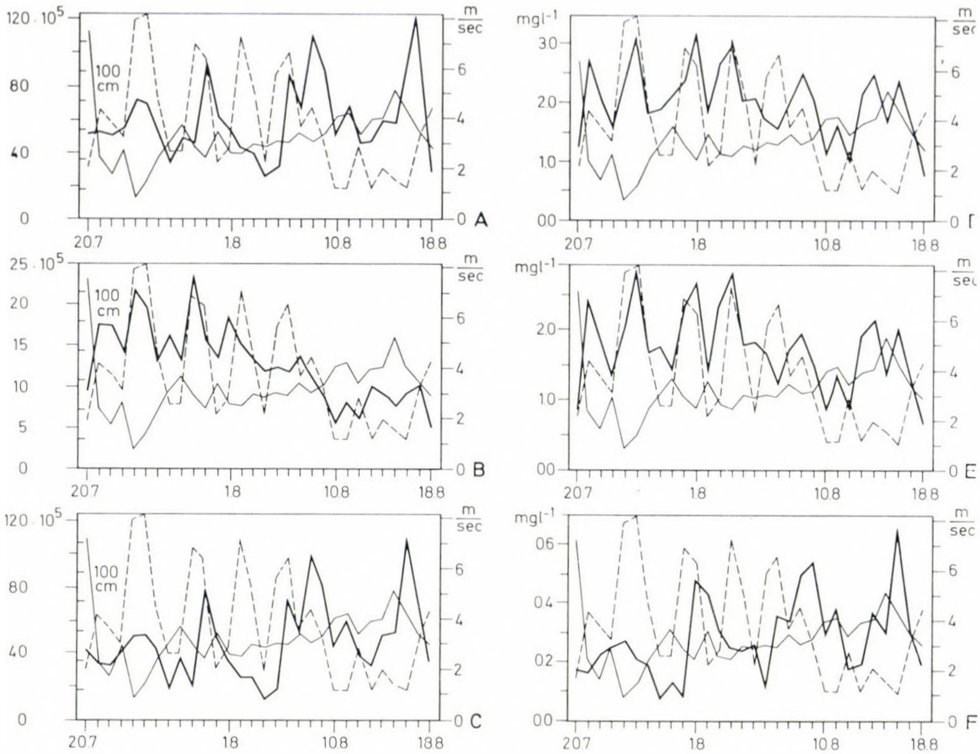

Fig. 5. Numbers and biomass of phytoplankton in the study period, with environmental factors indicated; velocity of wind — dashed line; SECCHI transparency — grey line; A — total numbers; B — numbers of macroalgae; C — numbers of microalgae; D — total planktonic phytomass; E — phytomass of macroalgae; F — phytomass of microalgae

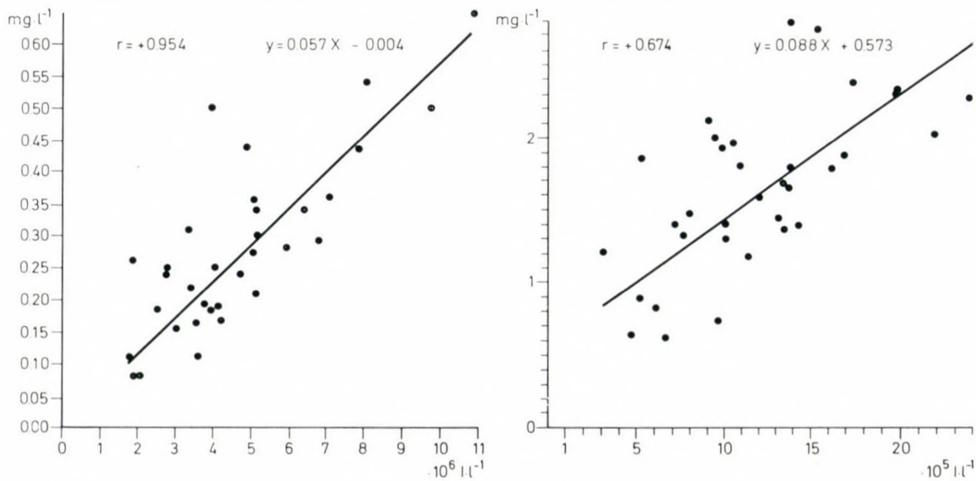

Fig. 6 a, b

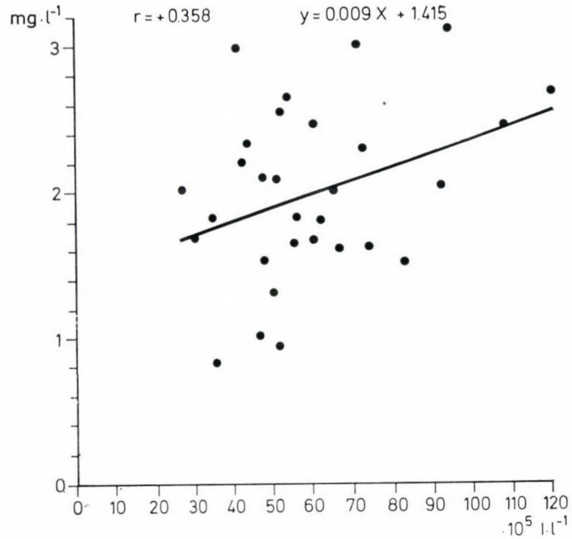

Fig. 6c

Fig. 6. a) Straight line of regression carried out on numbers and phytomass of microalgae (y) and the correlation coefficient (r); b) Straight line of regression carried out on numbers and phytomass of macroalgae (y) and the correlation coefficient (r); c) Straight line of regression carried out on total numbers and total phytomass (y) and the correlation coefficient (r)

When interpreting Fig. 6/a, 6/b and 6/c, the values of regression coefficients should be noted, where $a_a > a_b > a_c$, and $b_a < b_b < b_c$ (appropriate values for the regression equation of the figure) in the present case are measures of the indescribability of planktonic phytomass solely by numbers. In other words it means that a certain phytomass value cannot be coordinated with a given value of numbers. The more heterogenous the size distribution of the algae association (its spectrum) in the sample, the weaker the correlation between numbers and biomass. It should be noted here that a straight line of 45° from the origin would be obtained if the relationships between numbers and phytomass were separately investigated for each species.

The extreme illustrations in Figs 7 and 8 in which biomass maxima of macroalgae occur one day shifted compared to number maxima, led to the establishment of the above. This is related to the fact that treating algae above 10 μm size intervals, a "great collector" of variable content is dealt with, in which more sensitive algae dominate in featuring of numbers then in the featuring of biomass.

This thought is closely related to what has been said in connection with 6/a, b, c. The validity of the above conclusion can also be seen if the phytoplankton above 10 μm is divided into 10—40 μm and 40 μm— size intervals, and from the latter substracting the values of the largest algae of Balaton, *Ceratium hirundinella*, which moreover, reaches the maximum of its number

Table 3

The results of correlation analysis. Code: 1. Particulate organic carbon content ($mg \cdot l^{-1}$); 2. The velocity of wind ($m \cdot s^{-1}$); 3. The SECCHI-transparency (cm); 4. The temperature of water (°C); 5. The numbers of total algae ($I \cdot l^{-1}$); 6. The numbers of microalgae ($I \cdot l^{-1}$); 7. The number of macroalgae ($I \cdot l^{-1}$); 8. The number of algae between 10 μm and 40 μm ($I \cdot l^{-1}$); 9. Numbers of algae above 40 μm ($I \cdot l^{-1}$); 10. Numbers of algae above 40 μm minus Ceratium hirundinella ($I \cdot l^{-1}$); 11. Total planktonic phytomass ($mg \cdot l^{-1}$); 12. The biomass of microalgae ($mg \cdot l^{-1}$); 13. The biomass of macroalgae ($mg \cdot l^{-1}$); 14. The planktonic phytomass between 10 μm and 40 μm ($mg \cdot l^{-1}$); 15. The planktonic phytomass above 40 μm ($mg \cdot l^{-1}$); 16. The planktonic phytomass above 40 μm minus Ceratium hirundinella ($mg \cdot l^{-1}$)

Code	2	3	4	5	6	7	11	12	13	14	15	16
1	0.180	—0.440	—0.210				0.180	—0.299	0.302			
2		—0.503	0.024	—0.111	—0.010	0.796	0.530	—0.206	0.532			
3			0.360	—0.009	0.080	—0.781	—0.510	—0.139	—0.536			
4				—0.265	—0.802	—0.384	—0.380	—0.738	—0.201			
5							0.358					
6								0.954				
7									0.674			
8										0.760		
9											0.300	
10												0.920

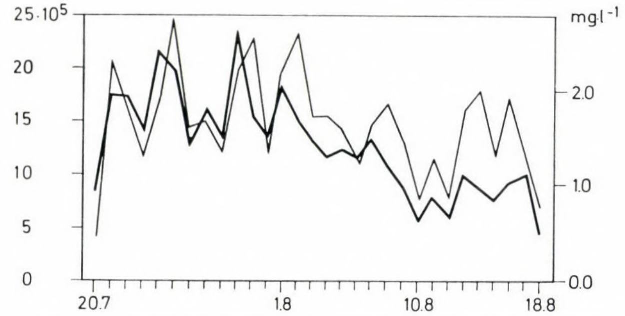

Fig. 7. Numbers (dark) and biomass (grey) of microalgae in the study period

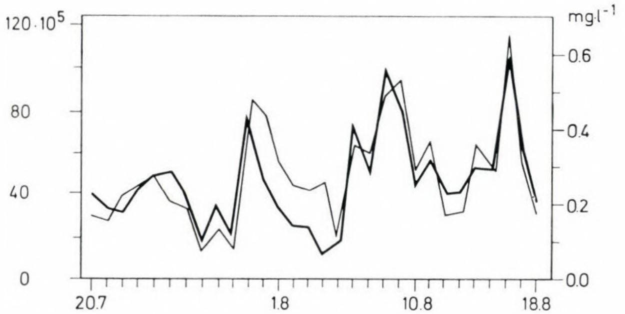

Fig. 8. Numbers (dark) and biomass (grey) of macroalgae in the study period

during the study period. The obtained picture with the correlation coefficients of the appropriate biomass-number pairs as follows:

$r = +0.300$ above 40 μm → $r = +0.920$ above 40 μm minus *Ceratium hirundinella*

↑

$r = +0.674$ above 10 μm → $r = +0.760$ 10 μm—40 μm

↑

$r = +0.358$ total numbers-total biomass → $r = +0.954$ below 10 μm

Thus it can be inferred that *Ceratium hirundinella* greatly influences the daily values of biomass, it reacts differently from, or at least more slowly than other algae species to environmental changes. It could be said that *Ceratium hirundinella* is characterised by a certain productional inertia.

The above makes it imperative that attention be drawn to the problems of sample evaluation and partitionings related to it, which are just problems

of theoretical ecology of today. To be concise, application of some arbitrary partitionings ($I \cdot l^{-1}$, etc.) should be reviewed when describing open-water planktonic relationships.

To return to Fig. 6, it should be noted in connection with the heterogeneity that its extent is also influenced by an algae lawn, which has already been proved to form on the bottom of the Lake in periods of calm (PANTOCSEK 1902) and which is stirred up by wind and waves from time to time and thus appears in the plankton samples. The benthic algae species, which appear on stormy days are: ***Surilella robusta*** var. ***splendida***, ***Cymatopleura solea***, ***Cymatopleura elliptica***, ***Diatoma vulgare***, ***Navicula cryptocephala*** and ***Campylodiscus*** sp.

Studying the planktonic phytomass and numbers separately in relation to temperature, SECCHI-transparency and mean wind velocity, the third proved to be the most decisive by numerical analysis, besides which the effect of water temperature — a degrading effect — is considerable (Table 3).

Since the correlational coefficients provide information merely for the degree of the stochastic relationship between the investigated factors, and make no mention of its nature, it seemed right to say that graphically, variables converge or diverge. For instance, comparison of phytomass and numbers with temperature proved to be difficult.

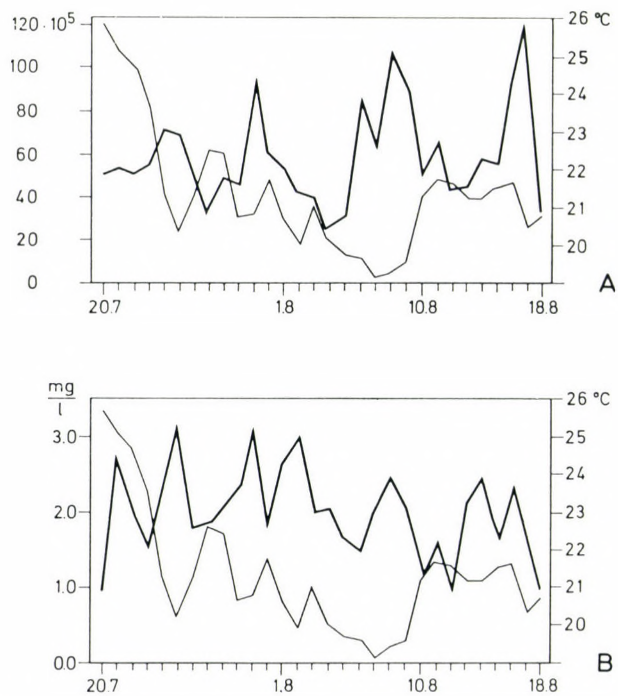

Fig. 9. A — Thirty day variations of phytoplankton numbers (dark) and water temperature (grey); B — Thirty day variations of planktonic phytomass (dark) and water temperature (grey)

Numbers and biomass showed opposite tendencies in relation to temperature, which is supported by the correlation coefficients. Assuming the presence of the already mentioned benthic algae-lawn, the following explanation can be given for the phenomenon: winds stir up the water, although no greater vertical stratification in temperature was experienced, and cooled it accompanied by stirring up of the benthic algae-lawn, thus increasing both numbers and biomass. It should be emphasized that this is only a partial explanation taking relatively small amounts of algae into account. HERODEK and TAMÁS (1975) experienced a similar phenomenon yearly.

The dependency of water transparency on atmospheric conditions due to the shallow mean depth of the Lake was as expected from data of the literature (CHOLNOKY and LÓCZY 1900–1912).

Correlation coefficients of $r = -0.503$ between SECCHI-transparency and velocity of wind and of $r = -0.781$ between SECCHI-transparency and numbers of macroalgae indicate stirring up of the benthic alga-lawn. Table 4 is an attempt to summarize, and from another aspect, tu support what has been said so far by carrying out a Path-analysis (SVÁB 1972) of parameters (temperature, SECCHI-transparency, velocity of wind) in relation to total planktonic phytomass. Special attention should be paid to the bottom line of Table 4, where besides the $(P_3) = -0.227$ Path coefficient of SECCHI-transparency — total planktonic phytomass relation, an indirect $X_2 = -0.212$ value is substracted by the stirring up effect of the wind, thus supporting the well-known stirring up effect of algae.

In connection with the Path diagram (Fig. 10) the fairly large value of $Ps = +0.557$ should be emphasized, which includes the effect of zooplankton and other factors not studied here and which, at the same time, points out the fact that the factors studied in the investigation are not sufficient for even a full description of synphenobiological aspects.

On the basis of the reasons in the introduction a separate investigation served to determine the particulate organic carbon content of the deliminated

Table 4

Results of Path-analysis with regard to total planktonic phytomass

The velocity of wind ($m \cdot sec^{-1}$) (X_1)	direct	—0.298
	indirect X_2	—0.009
	indirect X_3	—0.082
The temperature of water (°C) (X_2)	direct	—0.424
	indirect X_1	—0.059
	indirect X_3	0.113
The SECCHI-transparency (cm) (X_3)	direct	—0.227
	indirect X_1	—0.107
	indirect X_2	—0.212

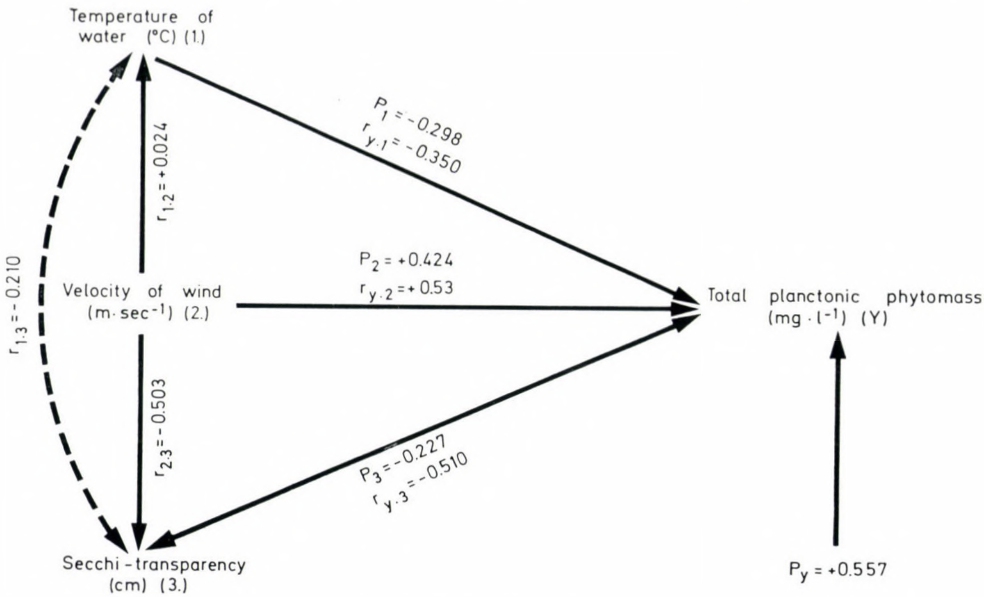

Fig. 10. The Path diagram

water area, which included organic debris and organic materials living at the time of sampling. Values, similar to other variables, greatly fluctuated. The average of 1.424 mg · 1^{-1}, which is well into the values characterising eutrophe waters, supports the problem of eutrophication which has been mentioned in the introduction and which has been referred to in recent years. On two occasions during the study period, hypertroph values have been determined (readings above 2.00 mg · 1^{-1}). It must be noted however that these two readings do not in any way indicate that the Lake is on the verge of hypertrophy, because on the one hand these values can be attributed to be the result of local pollution, and on the other hand the non-classic character of the Lake evokes an eutrophication process differing from the classical form. For instance, the development of the clinograde oxygen curve cannot be expected, whereas this is one of the strongest indications of eutrophication of classical lakes.

In order to reveal the relationships between planktonic phytomass and particulate organic carbon content, it was necessary to determine the carbon content of the phytoplankton (WINBERG 1971) and the following were obtained: the value of total particulate organic carbon content was one order larger than the one calculated for the phytoplankton (Fig. 11), thus providing hardly any information, but both showing similar tendencies. Taking into consideration the fact that values of particulate organic carbon content show abrupt increase on windy days, the decisive effect of wind conditions can be inferred from this aspect as well. To support this, the correlation coefficient between

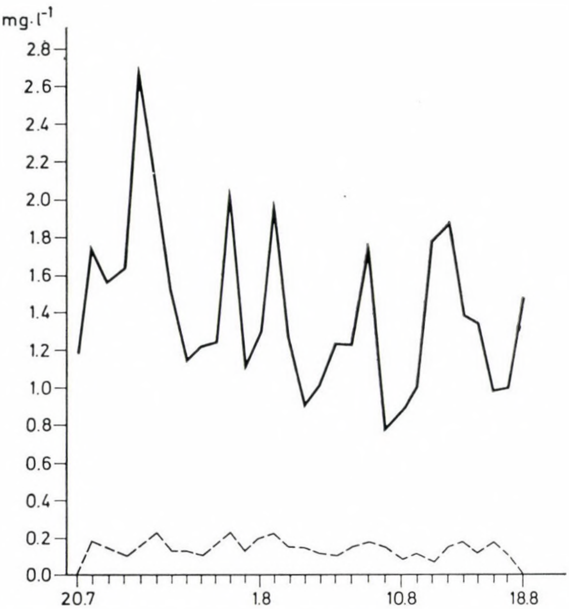

Fig. 11. Particulate organic carbon content of the water (dark) and calculated carbon content of planktonic phytomass (dashed line) in the study period

particulate organic carbon content and total planktonic phytomass is $r = +0.180$, but with a partial transformation which excludes the effect of wind, it can be increased to $r_{1 \cdot 12 \cdot 2} = +0.330$ (factors represented by the appropriate indices of r are in Table 3). Since this is also not a remarkably close value, a permanently present and accumulating organic mass is persumed (on the basis of organic carbon measurements carried out in the area in recent years, but unpublished so far)!

It was established that values of SECCHI-transparency were determined by weather conditions and were primarily dependent on the amount of detritus stirred up in the water by waves. The correlation coefficient between SECCHI-transparency and planktonic phytomass cannot be desribed as high, just as stands for $r_{3.12.1.2} = -0.33$ obtained by partial transformation which excludes the effect of wind.

Discussion

The previous section combined Results and evaluation because this was thought to be most effective way of treating the results, since comparable short-term studies have not been made on Lake Balaton. However it is necessary to supplement the previous chapter with a short discussion, which summarizes the major conclusions only.

Daily sampling in itself resulted in great fluctuations of all the studied variables, in which increase and decrease phases alternate in two–three-day periods. Daily values of planktonic phytomass show a standard deviation as it has also been shown. These conclusions bring up the problem of sampling intervals, which is a fundamental question in the planning of all ecological studies.

Difference in information content between numbers and planktonic phytomass caution investigators that this aspect must be approached thoroughly and in accordance with the requirements of the given study.

The applied membrane filtering technique, with all its draw-backs (i.e. taxonomically unaccurate), is more suitable for the quantitative investigation of microalgae of the Lake Balaton than UTERMÖHL's technique, since the disturbing effect of the ever-present detritus content of the Lake is eliminated. This method has revealed quantities of algae below the 10 μm size interval that exceeded previous expectations (HERODEK 1975). This fact requires that studies be carried out on microalgae from aspects of diversity and feeding biology. This has been a wish of the zoologists for some years (PÓNYI, personal communication), by means of which a sight into the mass and energy system of the Lake could be obtained. Moreover environmental factors not studied here could be taken into consideration, namely exact metering of light conditions and a parallel study of zooplankton as consumers.

High values of floating particulate organic carbon content of the water indicate eutrophication but some of the other data pointed to this as well.

ACKNOWLEDGEMENTS

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THE TREND OF THE PROTEIN FRACTIONS AND THE FIBRE CONTENT DURING THE DEVELOPMENT OF FRUITBODIES OF *STROPHARIA RUGOSOANNULATA* FARLOW EX MURR.

By

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Fungi belong to plants with a high protein content. It is a very important task that, in addition to the small number of species grown so far (*Agaricus bisporus*, *Pleurotus ostreatus* etc.), newer, valuable species should be drawn into cultivation, in this respect, physiological experiments are needed on a large scale. For example, we have only very few data on the trend on internal contents, among them mainly the quantity and ratio of protein fractions, or on the fibre content during the development of the fruitbodies. These were the points of departure in our experimental series related to two varieties (*Gartenreise* and *Gelb*) of *Stropharia rugosoannulata* Farlow ex Murr., a recently cultivated fungus. The results of our experimental series will be given in this paper.

Introduction

Researchers all over the world face the problem of drawing new species of fungi into agricultural production. This has gained growing importance partly from the viewpoint of protein production, and partly because the utilization of the increasing mass of agricultural and other waste materials of a high carbohydrate content may also be solved by it.

On the edge of emptied potato camps, on the decaying straw cover there usually appear *Stropharia rugosoannulata* specimens. They have since long been gathered and consumed in Germany, mainly in the autumn months. The technology of cultivation has been elaborated in the German Democratic Republic (PÜSCHEL, 1970); its experimental growing in smaller or greater areas has been started in Austria (ZADRAZIL—SCHLIEMANN, 1975), Czechoslovakia (FUNFALEK, 1973), and also in Hungary (VÉSSEY, 1972; BALÁZS, 1974). This mushroom can be grown in the bedding of straw of cereals. It has a fine flavour which is different from that of species put on the market so far.

A successful drawing of a new plant species into cultivation is possible only if one becomes familiar with its physiological characters, ecological requirements and their fulfillment to a possible optimum extent.

As regards the physiological and ecological requirements of *Stropharia rugosoannulata* Farlow ex Murr., and its suitable growth conditions, the

available data were mainly based on experience (VÉSSEY, 1972), and it was only recently that information on large-scale laboratory investigations became available from literature (ZADRAZIL—SCHLIEMANN, 1975). The experiments made so far show that Stropharia rugosoannulata may attain great importance if produced either on a small or an a large scale. Therefore it is essential that the most valuable items of its internal content, like protein and fibre, be known. The number of relevant literature data is small (LELLEY, 1976; PHAM VAN UT and SZABÓ, 1974), and even they refer only to the average fruitbody, and to its entirety. No examinations have been made in relation to either the changes in the inner content values during the development of the fruitbody or their distribution in the cap and stem. Our investigations concerned the changes of the parameters, important from the viewpoint of nourishment (crude protein, digestible and non-digestible protein, etc.), during fruit body growth and the existente of differences between the Gelb and Gartenriese varieties of *Stropharia rugosoannulata* Farlow ex Murr.

Materials and methods

According to the distribution data available so far, *Stropharia rugosoannulata* Farlow ex Murr. (Photo) is a circumpolar floral element: it has been described in Germany, France, Japan, and in the United States of America (HENNIG, 1965). It prefers the Atlanto Sub-Mediterranean climate, but it is found also in Czechoslovakia. On the other hand, it has not yet found wild grown in Hungary.

Simultaneously with its cultivation, divers strains with increasingly more favourable characters were selected from the matural variation scale of the wild grown mushrooms. In the GDR, *Gartenriese* and *Winnetou* are to be found among the new vegetable varieties marketed in 1970, and the *Gelb* variety (PÜSCHEL, 1972) in 1972.

The *Gartenriese* variety does not appear in groups, its average crop is 2—3 kg/m^2; the weight of a specimen surpasses even half a kg. While young, its colour is almost blackish brown, later dark rusty brown with a lilac hue.

The *Gelb* — the other variety of our experiments — has light lemon yellow and chrome-yellow caps, fading later into greyish light ochre. It has no special requirements and to yield fruitbodies already on the 65—70th day; the crop is ample, an average 6—8 kg/m^2.

The experimental cultivation of *Stropharia rugosoannulata* in the Botanical Garden of the Horticultural University at Soroksár was begun in 1973, under the guidance of Ede VÉSSEY (1972). Barley and wheat straw, mixed in various ratios, was used; as covering soil, a mixture of turf and garden soil was applied (F. NADABÁN, 1976). The cultures were placed in Holland beds in one of the sparse poplar woods. As provided by standard No. 13 646—75, related to cultivated *Stropharia rugosoannulata*, fruit bodies in four different stages of development were gathered from the *Gartenriese* resp. *Gelb* varieties. In group I, the cap is not or hardly open; in developmental stage No. II, the cap is completely opened, but its margins are still bending downward; the gills are still of a light colour; the ripening of spore has not yet started. Developmental stage III is immediately before the falling of the spores the cap is wholly developed. In Group IV, spore-falling is already heavy, the cap expended, its upper skin fading, the collar surface darkened by spore dust.

In the *Gelb* variety, several of the fruitbodies have grown very large, therefore it seemed reasonable to select fruitbodies which assumed variously large proportions into separate groups according to size, and then examine them whether it were profitable — with respect to the values of internal contents — to let the fungus attain such measurements more economical to gather then earlier than that. Considering their developmental stage, groups IV/A, IV/B and IV/C of *Gelb* are identical and characterized as Group IV of *Gartenriese* — by a heavy spore — falling. Specimens IV/A of 190—200 g had stems 15—16 cm long and 2.5—3 cm wide. Specimens IV/B had 140—150 g fruit bodies, but with a lengthy, 19—20 cm stem. Group

IV/C contained huge specimens of 200—350 g, a cap diameter 18—22 cm, stem 22—25 cm long and 3—4 cm thick.

We separated the caps and stems of the fruit bodies; after careful creaning they were sliced and dried at 80 °C up to loss constancy, then the specimens were ground and analized. The crude, digestible and non-digestible protein contents of the specimens, as well as the nitrogen content of the residue (non protein), and the crude fibre content, were determined at the Botanical Department of the UVS by means of the methods described elsewhere (Rimóczi and Vetter, 1976). When evaluating the data series, we calculated the arithmetical mean ($\bar{x}$), the standard deviation (s), and the standard deviation of arithmetical mean ($s_{\bar{x}}$) (after Sváb, 1973).

Results

Table 1 contains our data on the *Gelb* variety of *Stropharia rugosoannulata*. If the developmental phases are left out of consideration, in a comparison between the averages related to cap and stem parameters obtained in our examinations and those of similar data for fungus species examined earlier (see Table 2) it can be inferred that the crude and the digestible protein content, both in cap and stem, shows a very considerable, high value, and in the case of the cap it is the highest among all examined species. The ratio between cap and stem values of internal content is 1.52 : 1.55, which in the case of the Gartenriese variety lies between *Pleurotus ostreatus* and *Agaricus bisporus*. The above data, indicating the value of the variety, are not essentially modified by the relatively higher values of the other parameters either (non-digestible protein and non-protein nitrogen, crude fibre).

The crude protein content of the cap in Phase III (Fig. 1) reached a high, 717 mg value in comparison with the data occuring in the 459—583 mg/g dry weight interval of the other phases. Changes in the digestible protein values take a similar trend, and the data series of the non-digestible protein content also represents a high value (29.2 mg/g dry weight). Among the data of the residual nitrogen fraction not much of a similar relationship could be detected. Changes in the crude fibre content do not show a relationship with the developmental phases examined. By not considering the absolute values of the fractions, and by examining the changes in their percentage distribution (Table 3), we could experience a decrease in the ratio of digestible protein, and an increase to a small extent in the non-digestible protein and the residual N. These differences are, however, only of a few percent in magnitude.

When evaluating the stem data of *Gelb* variety (Table 1, and Fig. 1), we find that the *c*/*s*-ratio is about 1.5 in the case of the two main parameters (Table 2). The crude protein content is essentially unchanged, it moves around a 347—411 mg/g value; a deviation from this is the 260 mg/g datum of phase No. I. In displaying the changes in the crude- and the digestible protein content data in a comparison with the cap data (Fig. 1), the trend in the changes is of a similar character; however, in the case of the stem, the characteristic maximum observable in the cap is missing. This is shown in developmental phase

Table 1

Changes in the crude, digestible, non-digestible protein, non-protein nitrogen and crude fibre ($\bar{x}$: arithmetical mean; s: standard deviation;

		Phases of			
		I.		II.	
		cap	stem	cap	stem
Crude protein (mg/g dry weight)	$\bar{x}$	529.8	260.2	583.9	373.25
	s	34.4	17.0	14.6	6.7
	$s_{\bar{x}}$	19.9	9.7	8.4	3.9
Digestible protein (mg/g dry weight)	$\bar{x}$	495.7	210.8	537.3	331.2
	s	3.9	4.1	3.9	6.2
	$s_{\bar{x}}$	2.8	2.3	2.2	3.6
Non-digestible protein (mg/g dry weight)	$\bar{x}$	12.1	9.3	15.6	1.0
	s	2.8	0.8	1.9	1.4
	$s_{\bar{x}}$	2.0	0.6	1.4	1.0
Non-protein nitrogen (mg/g/ dry weight)	$\bar{x}$	3.5	6.4	4.9	6.0
	s	0.4	0.1	0.3	0.2
	$s_{\bar{x}}$	0.3	0.1	0.2	0.1
Crude fibre (in per cent of dry weight)	$\bar{x}$	9.3	11.2	11.4	5.0
	s	0.1	0.9	1.6	0.0
	$s_{\bar{x}}$	0.1	0.6	0.9	0.0

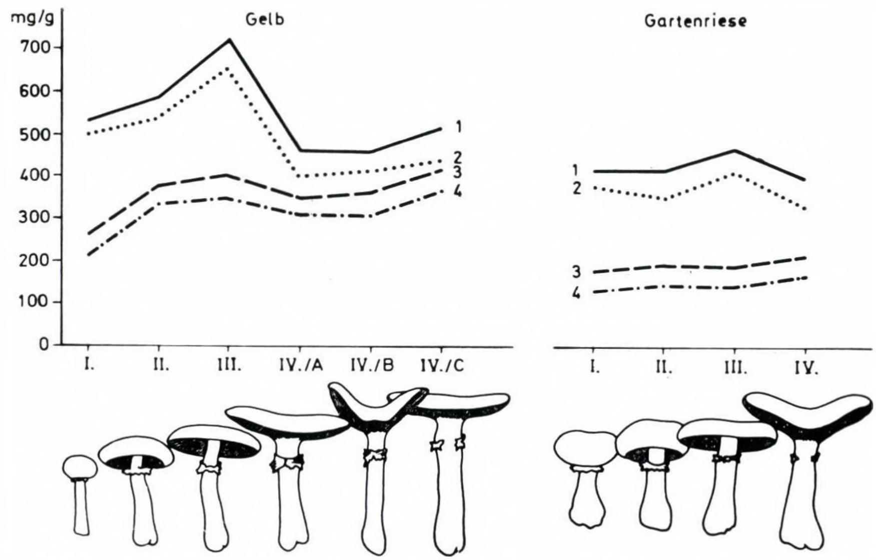

Fig. 1. The trend of the crude and digestible protein contents in *Gelb* and *Gartenriese* varieties of *Stropharia rugosoannulata* during the development. Abscissa: The stages of development, see the symbols; ordinate: protein (mg/g) 1: Crude protein in cap; 2: digestible protein in cap 3. crude protein in stem; 4: digestible protein in stem

contents in caps and stems of the variety Gelb of Stropharia rogosoannulata during development $s_{\bar{x}}$: standard deviation of arithmetical mean)

development							
III.		IV/A		IV/B		IV/C	
cap	stem	cap	stem	cap	stem	cap	stem
717.2	396.2	461.8	347.2	459.0	359.7	514.7	411.7
73.0	12.5	34.0	26.1	7.6	18.2	17.7	27.0
42.2	7.2	19.6	15.1	4.4	10.5	10.3	15.6
651.3	347.3	392.6	309.2	408.0	307.1	432.6	363.1
10.2	0.5	3.6	3.6	2.8	4.9	0.2	18.8
5.9	0.4	2.1	2.5	1.6	3.5	0.1	10.8
29.2	3.1	22.8	6.9	14.9	3.2	27.1	6.0
5.8	4.1	1.4	2.5	1.6	0.0	1.7	0.7
4.1	2.9	1.0	1.7	1.1	0.0	1.2	0.5
5.3	7.4	7.0	5.7	4.9	8.0	8.8	8.0
0.7	0.6	0.2	0.4	0.3	0.0	0.3	0.1
0.5	0.4	0.2	0.3	0.2	0.0	0.2	0.1
12.9	8.4	16.2	5.2	10.0	9.7	17.4	10.1
3.8	0.8	0.9	1.4	2.8	1.3	2.5	0.7
2.2	0.4	0.6	1.0	2.0	0.9	1.4	0.4

No. III. No systematic changes are exhibited by the data on non-digestible protein and the residual N fractions.

The analysis data on the *Gartenriese* variety are summarized in Table 4. In comparing these data with the corresponding values of the *Gelb* variety, of *Pleurotus ostreatus* and *Agaricus bisporus* (Table 2), we can state that the crude and the digestible protein content is lower and does not lag far behind the values of *Agaricus bisporus*, but essentially surpasses the corresponding averages of the *Pleurotus ostreatus* varieties. The favourable internal content values indicated above are paired with relatively high non-digestible protein, non-protein nitrogen and crude fibre values.

According to the changes in the crude protein content of the cap, the level is very stable (Fig. 1); it fluctuates around a 400 mg/g dry weight value, and it is only Phase III which deviates from this with a higher value. This value at the same time significantly deviates from the data of both the preceding phase and the succeeding phase (No. IV). The data of the digestible protein fraction show a similar picture, which is accompanied by also a significant difference (in comparison with the data of all the other phases). The parameters of the other fractions examined are essentially unchanged. When

Table 2

The values of protein and crude fibre contents in caps and stems of Stropharia rugosoannulata, Pleurotus ostreatus and Agaricus bisporus, and the rates of the values of caps and stems (3). The data were compared to the corresponding values of Agaricus bisporus (see: each second line)

	Stropharia rugosoannulata Gelb			*Stropharia rugosoannulata* Gartenrise			*Pleurotus ostreatus* average+			*Agaricus bisporus* ++		
	cap	stem	cap/stem	cap	stem	cap/stem	cap	stem	cap/stem	cap	stem	cap/stem
Crude protein (mg/g dry w.)	543.0	357.0	1.52	417.9	188.8	2.21	271.0	138.1	1.9	467.8	473.7	0.98
rate	1.16	0.75		0.89	0.39		0.58	0.29		1.0	1.0	
Digestible protein (mg/g dry w.)	485.0	311.0	1.55	361.0	143.4	2.52	246.0	116.0	2.1	426.2	432.9	0.98
rate	1.13	0.71		0.84	0.33		0.57	0.26		1.0	1.0	
Non-digestible protein (mg/g dry w.)	20.2	4.9	4.08	29.8	13.7	2.19	8.3	5.9	1.40	2.7	7.1	0.40
rate	7.5	0.69		11.1	1.92		3.1	0.8		1.0	1.0	
Non-protein nitrogen (mg/g dry w.)	6.0	6.7		4.5	4.6	0.96	2.8	2.7	1.03	6.2	5.4	1.15
rate	0.97	1.25	0.89	0.71	0.85		0.45	0.5		1.0	1.0	
Crude fibre (in per cent of dry weight)	12.8	8.3	1.54	9.32	11.2	0.83	5.3	7.8	0.70	8.3	8.3	1.0
rate	1.54	1.00		1.12	1.40		0.63	0.93		1.0	1.0	

\+ After Rimóczi—Vetter 1976
\++ Our unpublished data

Table 3

The changes of the protein fractions in caps and stems of the variety Gelb of Stropharia rugosoannulata during development (in per cent of the actual crude protein amount)

Phases of development		Digestible protein (in per cent of the crude protein)	Non-digestible protein (in per cent of the crude protein)	Non-protein nitrogen (in per cent of the crude protein)
I.	cap	93.7	2.3	4.0
	steam	81.1	3.6	15.3
II.	cap	92.2	2.7	5.3
	stem	88.7	0.3	1.6
III.	cap	90.7	4.1	5.1
	stem	87.7	0.8	1.8
IV/A.	cap	86.2	5.3	9.3
	stem	89.1	2.0	8.9
IV/B.	cap	88.9	3.3	7.8
	stem	85.5	0.9	13.7
IV/C.	cap	84.2	11.3	4.6
	stem	88.4	1.5	1.9

considering only the ratio of the fractions (Table 5), we experience a variability of a small extent only; the digestible protein content decreases by a few per cents, along with an increase of the same ratio in the other two fractions.

The crude protein content value of the stem is nearly half of the corresponding values of the cap in all phases, and essentially of a constant or a slightly rising tendency (Fig. 1).

The data of the above analyses of the varieties were examined also from other aspects of the developmental phases and growth of the fungus. From the data of ratios between fresh and dry weights of the gathered fruitbodies as well as between cap and stem weights, the parameters of the corresponding natural cap-stem ratios—that is, the ones reflecting the conditions of the undivided fruit body—were also calculated and taken into consideration (Table 6). According to these, the average fresh weight of the fruitbodies of, for example, the *Gelb* variety (Fig. 2) shows a maximum in phase No. IV/A, which is preceded by a gradual increase. Since the changes in the two data

Table 4

Changes in the crude, digestible, non-digestible protein, non-protein nitrogen and crude fibre content in caps and stems oft he variety Gartenriese of Stropharia rugosoannulata during development ($\bar{x}$: arithmetical mean; s: standard deviation; $s_{\bar{x}}$: standard deviation of arithmetical mean)

		Phases of development							
		I		II		III		IV	
		cap	stem	cap	stem	cap	stem	cap	stem
Crude protein (mg/g dry weight)	$\bar{x}$	411.4	173.4	409.1	189.6	459.5	184.2	391.9	208.3
	s	5.9	8.7	8.7	8.0	14.2	15.9	16.5	20.5
	$s_{\bar{x}}$	3.4	5.0	5.0	5.7	9.1	9.1	9.5	11.8
Digestible protein (mg/g dry weight)	$\bar{x}$	371.1	134.9	348.2	144.3	401.5	143.5	324.5	162.8
	s	2.3	5.1	1.9	2.7	10.7	3.3	6.4	1.5
	$s_{\bar{x}}$	1.3	3.6	1.1	1.5	6.1	1.9	4.5	0.9
Non-digestible protein (mg/g dry weight)	$\bar{x}$	26.7	20.6	32.3	12.4	29.2	11.7	31.2	10.0
	s	6.5	0.1	6.3	6.8	7.1	1.5	11.0	0.4
	$s_{\bar{x}}$	4.6	0.1	4.4	4.8	5.0	1.0	7.7	0.3
Non-protein nitrogen (mg/g dry weight)	$\bar{x}$	2.5	2.9	4.5	5.1	4.6	4.6	6.2	5.7
	s	1.0	0.1	1.0	1.1	1.1	0.2	1.7	0.1
	$s_{\bar{x}}$	0.7	0.1	0.7	0.8	0.8	0.2	1.2	0.1
Crude fibre (in per cent of dry weight)	$\bar{x}$	5.8	11.4	9.0	11.5	9.8	10.8	12.7	11.0
	s	0.4	0.7	0.9	0.7	1.3	0.5	1.5	0.1
	$s_{\bar{x}}$	0.2	0.4	0.8	0.5	0.8	0.4	0.8	0.1

Table 5

The changes of the protein fractions in caps and stems of the variety Gartenriese of Stropharia rugosoannulata during development (in per cent of the actual crude protein amount)

Phases of development		Digestible protein (in per cent of the crude protein)	Non-digestible protein (in per cent of the crude protein)	Non-protein nitrogen (in per cent of the crude protein)
I.	cap	90.3	6.5	3.2
	stem	78.0	11.9	10.0
II.	cap	85.1	7.9	6.9
	stem	76.4	6.6	17.0
III.	cap	87.4	6.4	6.2
	stem	78.0	6.3	15.6
IV.	cap	83.0	8.0	9.5
	stem	78.3	4.8	16.9

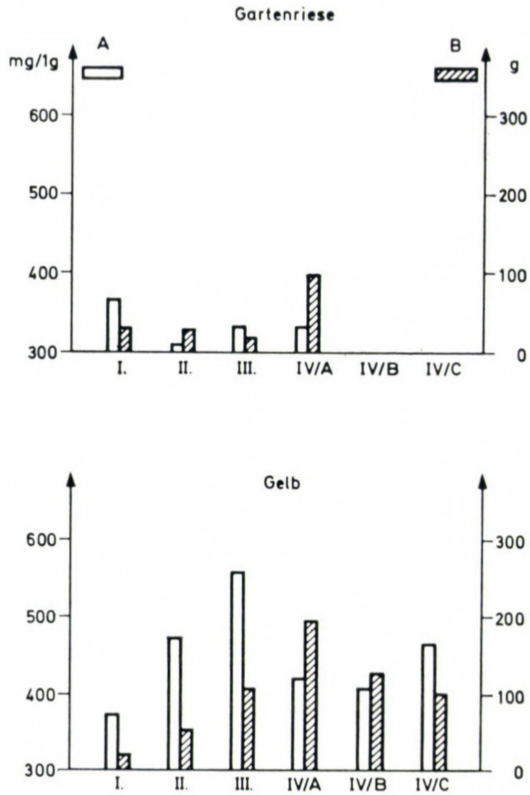

Fig. 2. The crude protein content of an average dry fruit body (A, unit: mg/g) and the average fresh weight (B, unit: g) in the cases of *Gelb* and *Gartenriese* varieties of *Stropharia rugosoannulata*. (Abscissa: the stages of development)

rows are of an identical character, it can be inferred that the dry weight level fluctuates only to a slight extent. The growing crude protein values — as against the identical dry matter level — in phases Nos I, II and III, calculated for 1 g of the average fruit body, indeed indicate a growing protein and nitrogen metabolism during development.

Gartenriese also reaches the highest average fresh weight in phase No. IV, but the developmental intensity of the fruit body is different from that of the *Gelb* variety. This keeps its fresh weight — reached already at the beginning of its development — through three stages, and the newer weight increase starts only simultaneously with the ripening of the spore, which means a fruitbody increase. As against this, its protein content, calculated for the weight unit of the dry fruitbody, remains unchanged.

Table 6

Changes in the fresh and dry weights and crude protein contents (calculated on the weight unit fruit body

	Phases of			
	I		II	
	Gart.	*Gelb*	*Gart.*	*Gelb*
Fresh weight of the average fruit body	29.0	19.4	28.2	52.2
Dry weight of the average fruit body	1.5	1.6	1.7	8.0
$\frac{\text{mg protein}}{\text{dry average fruit body}}$	366.6	373.0	310.8	473.5

Photo: A group of fruit bodies of *Stropharia rugosoannulata* of different development

of an average fruitbody) of the varieties Gelb and Gartenriese of Stropharia rugosoannulata during development

development							
III		IV/A		IV/B		IV/C	
Gart.	*Gelb*	*Gart.*	*Gelb*	*Gart.*	*Gelb*	*Gart.*	*Gelb*
18.2	107.6	89.2	196. 4	—	128.9	—	101.2
1.2	6.2	5.7	14.1	—	9.6	—	11.5
331.9	550.8	332.6	421.7	—	417.1	—	466.4

Discussion of the results

The experimental cultivation of *Stropharia rugosoannulata* Farlow ex Murr., both on a small and a large scale has come to the forefront of interest all over the world. Therefore it is justified to study the metabolic changes that accompany the morphological changes occurring during the development of the fruit body of the fungi, in both qualitative and quantitative respects, because it is only thus that we can determine the most advantageous time of gathering the fruit and the possibilities of processing the fruit bodies.

This species can be grown by small enterprises in extensive cultivation, because the protein content value is nearly identical with that of *Agaricus bisporus*, and its cap and stem values concerning internal contents are almost identical with, for example those of *Pleurotus ostreatus* (Table 2).

The fruitbody development of the two varieties examined is different, which is manifest also in respect of the internal contents. In the fruit bodies of the *Gelb* variety, the initial level of protein, taken in an absolute value, increases evenly up to the starting of spore ripening (stage No. III). Whereas in the fruitbodies of the *Gartenriese* there is no such change. On the other hand, the protein content of the *Volvariella volvaceae* Bull. ex Fr. (Sing.) fruit body — as stated by ORIOLLO and CARANGAL in 1961 (PHAM VAN UT, 1975) — decreases during development. The varieties examined by us reach their highest fresh weight at the time of their spore ripening, but with different values. The *Gelb* variety, together with its having different fruitbody ratios concerning both its stature and weight (IV/B, IV/C), surpasses the *Gartenriese* variety in which there were no such differences between the completely developed fruit bodies.

On the basis of the highest weight and internal content values, the most appropriate time of gathering the fruit is stage No. IV in *Gartenriese*. True, according to Hungarian standard No. 13 646—75, this qualifies only as a second class variety, for the mass of the ripe spores may darken the fruit body. However, by applying an appropriate technology in canning, this product can still be excellent. Its use in this way is also justified by the fact that earlier gatherings — for selling the fungi in the market — would provide a fresh product of a multiply smaller volume with the same quantity of protein content. According to the data of cultivating the *Gartenriese* either abroad (PÜSCHEL, 1972) or in Hungary (F. NADABÁN, 1976), its gathering as a first class product for direct consumption is not profitable when calculated for a unit of production area. On the basis of our data related to the internal content values and development of the stem, the stage of gathering and use as suggested here may favourably modify the picture drawn on the values of the variety so far.

The most favourable time of gathering depends also, in the *Gelb* variety, on the mode of utilization. In stage No. III, before spore ripening, its protein content is the highest (Fig. 2), its appearence the most favourable, therefore gathering for selling it on the market is the most appropriate at this time. If we wait until the spore is ripe and fallen (phase No. IV), the fruit is darker as a whole; even though its protein content decreases this is counterbalanced by the weight increase which is almost double. Therefore this is the most appropriate time of gathering the fruit bodies for canning or dehydration. The yield of the *Gelb* variety, if calculated for a unit of production area, is high, the high protein content, compared with that of other fungi, and the favourable composition of the protein content, further increases the cultivation values of this fungus. This is especially so if we apply, during cultivation and processing, the considerations described above with respect to fruit body development and internal content values.

According to our data, even in specimens which can be classified as first class ones on the basis of the Hungarian standard essential internal content values, as for example the quantity of protein fractions, may differ considerably. This must be taken into consideration during processing (e.g. for powder), mainly with respect to the *Gelb* variety.

Summary

The authors examined the changes in the various protein fractions (crude, digestible and non-digestible fractions), non-protein (residual) N fraction and crude fibre contents of the cap and stem of the *Gelb* and *Gartenriese* vaıieties of *Stropharia rugosoannulata* Farlow ex Murr. The aim of their work, carried out in the Botanical Garden of the Horticultural University

and in the Botanical Department of the UVS, was to study the trend of changes prevailing in the various phases of the development of fruitbodies and separately in the cap and the stem, the optimum time of gathering to be chosen accordingly, and last but not least, the values represented by the two varieties of *Stropharia rugosoannulata*.

On the basis of specimens taken at four developmental stages (I: the cap not or hardly opened; II: the cap opened, spore — ripening still absent; III: immediately before spore-falling; IV: cap fully developed, spore-falling) the following statements can be made:

1. The crude- and digestible protein content of the cap and stem in *Stropharia rugosoannulata* is high. In *Pleurotus ostreatus* (Jacq. ex Fr.) Kummer the cap and stem are richer in digestible protein, and the protein content of the *Gelb* variety cap overpasses that of *Agaricus bisporus* (Lange) Singer. The fact that the differences in the internal content values of cap and stem are not too great is a favourable circumstance.

2. On the basis of the parameters examined in the two varieties, it can be stated that in developmental phase No. III, the cap of *Gelb* shows a maximum of crude- and digestible protein content, and the tendency of changes in the *Gartenriese* data is similar. The stem data in both of the varieties move essentially on a constant level. During the developmental processes of the fruitbody a considerable increase in the protein quantity appears therefore between developmental phases Nos II and III.

3. The percentage distribution of the crude protein contens in the various developmental stages changed only to a small extent (the digestible fraction decreased, the ratio of the other fractions increased only slightly).

4. If we consider also the changes in the fresh and dry weight averages of the fruitbodies in our data processing, and make our calculations with the crude protein values related to the average fruitbody weight unit, the pictures obtained for the two varieties will be somewhat different. However, it is best, in the case of both varieties, to await the onset of developmental phase No. IV — considering also the requirements and possibilities of the conserve industry. The quantity of protein present at this phase is slightly smaller if related to the weight unit, but if taken together with the rest of the phases this quantity is the greatest.

5. The crude fibre content of the species does not differ from that of the other cultivated fungi, and it fluctuates irregularly during fruitbody growth.

6. Our data confirm that *Gelb* is the more valuable of the two varieties.

With our results we should like to contribute to a better understanding of the fruitbody growth and developmental processes of *Stropharia rugosoannulata* as well as to the working out of even more efficient technologies of cultivation, and, last but not least, to the cultivation of this very valuable fungus species on a larger scale.

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Preliminary Announcement

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RECENSIONES

L. Bogorad, J. H. Weil (eds.): Nucleic Acids and Protein Synthesis in Plants. Plenum Press New York, 1977. pp. 417

The book contains the text of the 24 lectures delivered at the Colloquim held in Strasbourg (France) on 15—24 July, 1976. The lectures faithfully reflect the far-reaching research trends in plant molecular biology of our days. Although these researches turn to fundamental biological problems, the research results are also useful for the purposes of agriculture. The lectures can be summarized into the following greater thematical units:

a) The organization and replication of nuclear and chloroplastic genomes. Two lectures were delivered on this topic; one of them deals with the DNA synthesis taking place during the microsporogenesis of *Lilium* (Herbert Stern), the other reports on the electronmicroscopic and ultracentrifugal examination of the circular DNA (ctDNA) of chloroplastics, in the course of which data were obtained on the measure, structure, denatural and renatural as well as hybridizational characters of ctDNA (K. K. Tewari and co-workers).

b) Three of the lectures dealt with transcription. The lecture summing up the production and characterization of the RNA polymerases occurring in the hypocotyl cells of soya (Tom J. Guilfoyle and Joe L. Key) is interesting also because it makes the mechanism of cell growth more understandable; for, during the auxine-induced growth, the RNA metabolism, and parallel with it the RNA polymerase-I activity too, considerably change in the hypocotyl tissue of soya. In examining the transcription of the nuclear genome of *Acetabularia*, we can get an answer to morphogenetical questions (Hans-Georg Schweiger), and again the separation, by means of agarose-polyacrylamide gel electrophoresis, of ribonucleic acids which are quick to be marked, and of great molecular weight of the synthesized cytoplasmic, chloroplastic and mitochondrial ribosomes of the cell cultures (*Petroselinum*, *Pisum*, *Acetabularia*, *Cyanidium*) incubated with [^{3}H] uridine, leads to a better understanding of the operation of cell organelles (G. Richter and co-workers).

c) Translation: the apparatus of protein synthesis. The protein synthesis of plant cells takes a different course in the cytoplasm, the chloroplastics and the mitochondrium: the protein synthesis of the organelles is much more similar to the synthesis taking place in the procaryotic cells than to the mechanism of the protein synthesis of the cytoplasm. The five lectures on the topic provide important data also for the understanding of cellular evolution (endosymbiotic v. non-symbiotic evolution). Transfer RNAs and aminoacid-transfer—RNA-synthetases in the plant cytoplasm, chloroplasts and mitochondria: they can be found in cell organelles, and are similars to bacterial organelles (J. H. Weil and co-workers). The ribonucleic acids of small molecular weight of the plant ribosomes, their structure, function and evolution: the sequence of 5S rRNA occurring in chloroplastics essentially differs from the cytoplasmatic 5S rRNA and is rather more similar to the nidulant 5S rRNA of the *Anacystis* (T. A. Dyer and co-workers). The lecture dealing with the genetics of ribosomes of the chloroplasts called *Chlamydomonas reinhardi* also presents a short evolutionary evaluation and, besides, it reviews the cluster-cone hypothesis of the origin of eucaryotism (L. Bogorad and co-workers). Protein synthesis in plants: the lecture entitled "The specificity and role of the cytoplastic and organellar systems" (C. Ciferri and co-workers) provides a clear picture of the questions mentioned. Seal and co-workers delivered a lecture on the functional characteristics of the initiating factors of wheat germ.

d) The nucleic acid and protein synthesis of cell organelles: the relations between organelles and cell nucleus. The three lectures on the topic touch upon genetical and evolutionary problems as well. The lecture discussing the phenotypical markers of the DNA gens of chloroplasts (Kevin and co-workers) examines primarily the results related to the synthesis of the proteins in *Nicotiana* Fraction I, from the viewpoint of biochemical genetics. The lectures discussing the protein synthesis of chloroplasts (R. John Ellis) and the biosynthesis of the mitochondrial proteins (C. J. Leaver and P. K. Pope) are important summaries of the results obtained in the field.

e) The effect of hormones and environmental factors on the synthesis of nucleic acids and proteins. Five of the lectures belong to this topic. Light is an important factor in the regulation of RNA and protein synthesis taking place in plants, by means of photoreceptors, phytochromes, which are of the nature of a protein (H. Mohr and P. Schopfer). Donald Boulter summarizes the synthesis and accumulation in the seed of the protein of cereals and leguminous plants, from biochemical viewpoints as well as of nutrition. The biochemistry of germination was dealt with in the lectures discussing the transformation and regulation of the stored mRNA of dicotyledonous seeds (Leon S. Dure III and Byrry Harris), and the hormonal regulation of protein synthesis (J. E. Varner). The regulation of plant growth through protein kinases: phosphorylation of the ribosomatic protein, that of histone-I, is dealt with in the lecture of A. Trewavas and B. R. Stratton.

f) There are six lectures on the topic dealing with plant viruses, *viz.*: The general characteristics of the isolated protoplasts, and the alien genetical material uptake (DNA and viruses, organelles and microorganisms), the fusion of protoplasts (E. C. Cocking); the segments of the plasmid of *Agrobacterium tumefaciens* responsible for the induction of the crown gall tumours (J. Schell and co-workers). The lecture of J. P. Briand and co-workers describes the nucleotid sequences of the RNA of plant viruses (Turnip yellow mosaic virus, tobacco mosaic virus). The recently recognized subviral pathogens, the viroids, owing to their pathogenic effect, are of great importance in agriculture. Their biochemical characteristics and replication are described by T. O. Diener. The aminoacylation of the viral RNA can be involved in the regulation of replication or transformation; aminoacylation is dealt with in the lecture of M. Pinch and co-workers, while L. van Vloten-Doting and co-workers give a picture of the *in vivo* and *in vitro* transformation of the RNAs in the alfalfa mosaic virus.

It is characteristic of all the lectures of the volume that they give a clear, comprehensive picture of the topic mentioned in the title, illustrated with figures and tables persuasively, in such a way as to present each as an entity within the whole.

S. Szilágyi

Kedves, M.: Paleogene Fossil Sporomorphs of the Bakony Mountains. Part III. Studia Biologica Academiae Scientiarum Hungaricae 15, pp. 161, XXIV Plates, 1978

The palynological description of the paleogenic flora of the Bakony Mountains is published in the series Studia Biologica in which the present Part III is at the same time the last taxonomical volume in the series. After Part I (1973) and Part II (1974), this work contains the description of further thirty-three form-genus specimens, among them the description of several new species. The description of the new species is illustrated by clear drawings, in addition to the photographs.

In the introduction, the author also touches upon some morphological and denominational problems. This is followed by a taxonomical part, in which the general description and literary survey of the various form-genera are followed by the enumeration of the species explored, together with an accurate determination of their habitat and age. The sporomorphs which have been examined originate mainly from boreholes, their age is mostly eocene, from the various periods of the Eocene. The volume contains twenty-four plates of photographs, which illustrate the flora that have been elaborated well. At the end of the volume a detailed list of references and also an expediently arranged subject-index can be found. The value of the work is increased by the appropriate editing and the nice layout. On the basis of the preceding two volumes of the series, the researchers dealing with tertiary palynology are already familiar with the subject. This volume provides both foreign and Hungarian paleobotanists, beyond those working in the narrower specialist field, with an important addition to the knowledge of Hungarian Eocene paleoflora. The macroflora of the area examined, and in general the macroflora of the Hungarian Eocene is poor. It is therefore the abundantly occurring microflora that gives information on the flora of the Hungarian Eocene.

L. Hably

J. B. MUDD and T. T. KOZLOWSKI (eds.): Responses of plants to air pollution. Physiological Ecology series 11. Academic Press, New York—San Francisco—London, 1975, 383 pp.

Volume 11, appearing in the book series entitled "Physiological Ecology", edited by T. T. KOZLOWSKI and J. B. MUDD, presents the readers an important and timely topic of physiology and ecology, again. Recently, this branch of ecology and ecophysiology has reached into the centre of researches. The powerful development of industry and agriculture today produces a large quantity of pollutants (gases, particulates, radio-active agents, etc.), which pollute the air, the soil and the waters. A large part of the pollutants is toxic to living cells, owing to their chemical characteristics or high concentration. In a last analysis, these toxic agents directly or indirectly endanger the health of man. They make harmful effects on the structure and functions of the ecosystem of our natural environment, and they also influence the quantity and quality of agricultural production. After recognizing the very dangerous character of pollutants, the ecologists and physiologists have set out to examine with great intensity the effect of pollutants on living beings. They carry out all this work in the interests of preserving the health and the natural environment of man. On the basis of these examinations, increasingly more scientific reports and books come to existence.The present book also joins in this topic, that is it deals with the results of the investigations and experiments into the biological, biochemical effects of air-polluting materials on plants and it draws conclusions from the results. Although a relatively great number of books have been published in connexion with air pollution, there are probably only a few of such that deal with the biological effects of air pollution. This is why we think the publication of this book will be specially welcome.

It embraces comprehensive field of knowledge on a large scale. After the introduction, the most important pollutants and their effects are discussed, then the interactions between pollutants and plants are dealt with.

Chapter 1 — Introduction. It gives a short summary of the contents of the book. The most important air pollutants are described, their origin and their quantity contained in the atmosphere, together with their harmful effects and the mechanism of their destructive effect are also dealt with.

In Chapters 2—7, the most important air pollutants and their effects are discussed separately, in a chapter each, *viz.* sulphur dioxide, ozone, fluorides, peroxyacyl nitrates, oxides of nitrogen, particulates.

Chapter 2 — Sulphur dioxide. This air pollutant has been known for the longest time. It derives primarily from the burning of coal and oil into the air. The chapter deals with the symptoms, physiological and biochemical effects of the destruction. Among the physiological effects, those on stomatal opening, amino acidic composition, photosynthesis, and on chlorophyll are dealt with here. Among the biochemical effects, the reactions between SO_2 and aldehydes, ketones, olefine compounds, disulphides, pyrimidines, pyrimidines and enzymes as well as their consequences are described in this chapter.

Chapter 3 — Ozone. After describing the chemical properties of ozone, this chapter deals with the effects of ozone pollution. Among the polluting effects, those on the tissue structure of the leaf and especially on the palisade parenchymatous cells are mentioned. Among the physiological effects, those on the formation of cell walls (primarily through the inhibition of the UDP-glucose polysaccharide synthetase enzyme), as well as the effect of ozone on the permeability of plasmolemme is emphasized by the writer of this chapter, J. B. MUDD. Among the biochemical effects of air pollution, several examples of those on cytoplasmic biochemicals are to be found. We can read about the secondary reactions of air pollution, namely, the reactions taking place between ozone and sulphhydryls, amino acids, proteins and reducing sugars. At the end of the chapter, the author puts several interesting questions which are awaiting answers from future researchers into this field of science.

Chapter 4 — Fluorides. In this chapter we can read about the absorption, accumulation and translocation of fluorides in plants and also about the effect of fluorides on the various metabolites, respiration and the biochemical reactions related to them, and on photosynthesis, pigments, growth and the related biochemical metabolites; the whole question is discussed on the basis of source materials used in a great number.

Chapter 5 — Peroxyacyl nitrates. A secondary pollutant, forming in the course of photochemical reactions, from the oxidation of hydrocarbons deriving from the primarily escaping gases together with other, secondary pollutants (aldehydes, ketones). We can read in the chapter also about the symptoms of PAN destruction, as well as about the physiological and biochemical effects of pollution. Among the biochemical effects, the inhibiting or modifying effects of PAN on the hydrocarbon metabolism, photosynthesis and other biochemical processes, or on some specific biochemicals (nicotinamide, sulphur-containing compounds, purines

and pyrimidines, olefines, amines) are dealt with. In addition to the destruction caused in plants, another effect of pollution, the irritation of the human eye, is also discussed, with respect to the damage caused by PAN and aldehyde compounds.

Chapter 6 — Oxides of nitrogen. At the beginning mention is made of the formation and of the chemical properties of these compounds (NO, NO_2). They, together with the former pollutant, take part in the formation of oxidant among. In the further parts of the chapter, the authors deal with the mechanism of destruction in plants, and with the effects of these compounds on plants of higher order. From this chapter the reader may become familiar with the NO_2 resistance of many agricultural and garden plants, deciduous tree species and pines. The authors classified the plants by the NO_2-resistance of their leaf into resistance groups.

Chapter 7 — Particulates. As is stated also by the authors, their effects on plants are less known. The effect of soma particulates on the vegetation is described. For example, the effects of cement-kila dust, fluorides, lead particles, soot, magnesium oxide, iron oxide, etc. Cement-kila dust and its direct physical and chemical effects are described by the authors in detail.

Chapter 8 — Plant responses to pollutant combinations. In this chapter, the authors describe the effects of some combinations of air pollutants (sulphure dioxide-ozone, sulphure dioxide-nitrogen dioxide, sulphure dioxide-hydrogen fluoride, and other pollutant combinations) on plants, on the basis of related experiments and observations.

Chapter 9 — Effects of air pollutants on plant ultrastructure. On the basis of scientific reports available, the author describes the effects of the most important air pollutants (ozone, peroxyacyl nitrate, nitrogen dioxide, sulphur dioxide, ethylene, fluoride). He writes about the harmful effects, lesions that ensue in the leaf, cell and mainly in the chloroplastice of plants. The effects of pollutants in the ultrastructure of the cells is illustrated by the author with appropriate electron microscopic pictures.

Chapter 10 — Effect of air pollutants on forests. At the beginning of this larger chapter, the authors write about the classification of the forest ecosystems and forest types of the USA, and about the dynamics of the ecosystems, in short. Then we can read about the destruction primarily of forests in USA and Canada. The forests of some European countries are however also dealt with (England, West-Germany), We can read about the origin of sulphur dioxide, fluoride, ozone and oxidant pollutants, and the extent of their pollution in the above countries also in detail. Besides, mention is made of the detection of pollution and of the ecological and the phytocenological consequences of pollution. At the end forests as air-polluting sources are dealt with. Information is given on the fact that the canopies of forests emit a considerable quantity of photochemically reactive hydrocarbons into the atmosphere of the earth (175×10^6 tons). Mention is made of the mono- and hemiterpenes emitted by the forest tree species, and of the way particles, together with the part played by them in the formation of blue haze.

Chapter 11 — Effects of air pollutants on lichens and bryophytes. In this chapter, the authors describe in detail the methods of investigation used for the detection of pollution. Thus they write about the ecological and phytosociological methods (vegetation mapping, poleotolerance index and biological scales), as well as the ecophysiological methods (studies under field and laboratory conditions, reproduction and fertility, species susceptibility, etc.). By means of the description of the methods, information is also given on the effect of important pollutants on lichens and mosses, and we shall become familiar also with the sensitivity of the various species, with the help of the surveying of a great number of experimental results and observations.

Chapter 12 — Interactions of air pollutants with canopies of vegetation. In the first part the authors deal with the composition of the lower atmosphere, and with the circulation of pollutants in general. In the further parts of the chapter we can read about the metabolism of pollutants taking place in the canopies of vegetation or on the surface of the leaves, about the methods of their measuring. Some methods are described on detail: wind profile (aerodynamic method, electrical analogue simulation method, canopy pollutant sink properties).

Chapter 13 — Interaction of air pollutants and plant diseases. In this chapter, a detailed description is given on the effect of sulphur dioxide, fluoride, and ozone pollution on the pathogenic fungi, bacteria and viruses as well as on the arising of diseases and their progress.

Chapter 14 — Interactions of air pollution and agricultural practices. At the beginning, we can read about the effects of some cultural practices applied in agriculture (for example, plant nutrition, irrigation, resistent crops) on the destruction of plants or on their sensitivity. In the further parts of the chapter, the author deals with pesticides (herbicides, insecticides, fungicides). Pesticides as air pollutants have direct effect on agricultural plants; as phytotoxins, for example, by being inhibitors in pollination and in reproduction, with their influence

on the metabolism of plants. Besides these, mention is made of nitrogenic and phosphorous fertilizers as pollutants, which come into the air mainly in the course of their production and application.

I think even from this short review it has become clear that the volume is comprehensive, contains a many-layered material, is concerned with several fields of science and therefore provides a very good compilation of the topic. The authors review and report on several bibliographical items in the various chapters, which makes the book even more valuable. Thus the material of the well-edited book may provide great help not only for the specialists working in the field of plant physiology and ecology but also for those working in other areas, as for example, town-planning, industry-planning, preservation of the environment, etc. It may become of great use for students of environmental biology, and also for teachers of the topic.

Considering its valuable, novel material discussed on a large scale, I should definitely recommend this book to home ecologists and specialists dealing with the preservation of the environment.

L. B. Papp

L. Hodges: Environmental Pollution, 2nd edition. Holt, Rinehart and Winston, 1977 pp. 496.

This book has to be written to fill the need for a one volume scientific discussion of environmental pollutants, their nature, their effects on plants, animals and people, the method, by which they can be avoided.

Following the introduction there are fourteen chapters ranging over several subjects, all of them introduced by a quotation, indicating the earlier problem sphere connected with environmental pollution.

The chapters are arranged in the following way:

Population increase. (Discussing the speed of population increase and its effects.)

Air pollution. (Several sorts, their effects, control and how to remove them. A special attention to the problems of sulfur oxides, carbon monoxide, hydrocarbons, nitrogen oxides, particulate matter, ozone is paid.)

Noise. (Discusses the measuring methods, effects of people, hearing losses, sources of noise and the works of "Noise Control Act 1972".)

Water pollution. (Contains the municipal, industrial and commercial pollutions and besides that, the treatment methods.)

Agricultural problems. (We can find here the problems of oxygen demand (BOD) and pesticides.)

Solid wastes. (The sorts, amounts and disposal methods of wastes. Source reduction, resource recovery.)

Pesticides. (Use of chemical pesticides in recent years. Developing resistance to pesticides. Human illnesses.)

Thermal pollution. (The effects of several sorts of projects, and industrial processes. Cooling.)

The radiation. (Somatic and genetic effects, advantages and disadvantages of nuclear plants. Ionizing radiation.)

Energy. (Alterations and need of energy. Energy resources.)

Foods, drugs, and cosmetics. (Legislation.)

Metal pollution. (Several poisonous metals and their effects on vegetation, animals and human beings.) Economic and legal questions. (Reducing the social cost of pollution and the control.)

Environmetal actions. (Works for declarations on the environment. Environmental groups and successes.)

There are synoptical tables in the book, showing us the rise of pollution in time, amount and space and the cost of cleaning. These show us the hazards of the technologies and their effects on the living world.

Especially on plants

sulfur dioxide above 0.03 ppm causes acute leaf injury,
the ethylene to inhibit plant growth
the nitrogen oxide to reduce growth
the fluorides to reduce growth and
copper causes total degradation (there are no plants around the mines).

At the end of the chapters there are summaries, references, questions and activities. The questions can be used excellently for revising the problem of the chapter, and by means of this, the book assumes the character of a manual. Under the activities the author raises

new questions and urges the reader to make observations and alterations in the environment.

Though this book does not make many references in relations to Asia. Africa and Australia, its statements are general, so it can be used by scientifical workers and engineers to get to know the environmental problems.

E. FEKETE-SZŰCS

WILLIAMS, W. T. ed.: Pattern Analysis in Agricultural Science. Elsevier Scientific Publishing Company. Amsterdam—Oxford—New York, pp. 331, 1976.

The editor writes in the preface that this book has been written for agricultural research workers but I can recommend it to every botanist who wants to obtain an insight into pattern analysis. The term "pattern analysis" is used in a general sense to cover any technique of classification and ordination (this use is now widespread in Australia but not in other countries).

This book falls into three sections. The authors of the first two sections are well-known representatives of the Australian taxonomic school. The last section has been written almost entirely by agricultural researchers.

In the first section we find a brief account of elementary matrix algebra illustrated by biological examples. This summarization is indispensable especially for biologist who wants to utilize oridination procedures in his work.

The second section outlines the theory and present stage of ordination and classification methods and explores their relationship to the conventional statistical methods. Prior to the detailed discussion of numerical techniques the different attribute types are presented (Chapter 5.). After this the most important similarity measures are described. We can also find a simple artificial example illustrating how to choose the suitable measure (Chapter 6.).

The following three chapters deal with the ordination procedures. After the discussion of some basic ordination problems we are made acquainted with a geometrical approach to a widely used analytical method which is universally known as "principal component analysis" (P.C.A.). The computational steps of P.C.A. are demonstrated by an example without however, a detailed and, perhaps, exhausting mathematical explanation. Special problems and properties of P.C.A. are also discussed. The author gives a review on other ordination procedures suggesting the use of a relatively simple and widely applicable method known as "principal co-ordinate analysis". Factor analysis *sensu stricto* and canonical analysis are dealt with in short. Recent developments and future possibilities of ordination methods are finally outlined.

The other important family of methods i.e. the classification procedures are discussed in five chapters (from Chapter 10 to Chapter 14). First the classificatory strategies are "classified" and illustrated by an appropriate dendrogram. After the general characterization of classification methods the author gives a detailed description of hierarchical agglomerative strategies. A linear model constructed by the authors is presented for calculating inter-cluster similarity (this model, I think, is well-known from the literature). The discussion of divisive strategies is concise, but perhaps it should have been more detailed since divisive methods have played a central role in numerical taxonomy for years. The next chapter deals with the problems which may arise in the interpretation of dendrograms. Recent advances and possibilities of clustering methods are concluded in Chapter 14.

Basic computational considerations are outlined in Chapter 15. After this short descriptions of ten Canberra programs are presented.

Terminology used in this book is cleared up in Chapter 17. As it is mentioned above, the term pattern analysis implies any ordination and classification methods. The problem of objectivity concerning the pattern recognition is discussed and illustrated by the comparison of two alternative classifications of the same set of data. Relationships between pattern analysis and statistics are examined by distinguishing five situations in which pattern analysis may be used alone or combined with statistical procedures.

The last section of this book contains a set of twentyone cases which demonstrate in an excellent way how we can adopt the pattern analytical methods to solve different problems. These examples convince even the most sceptical biologist of the efficient properties of ordination procedures and cluster analyses. The first case reports a numerical taxonomic study of the genus *Stylosanthes*. Morphological and agronomical data were recorded and analysed by three methods. In Case 2. we find a classification of sites where some *Stylosanthes* species were grown. Case 3. contains a classification and two ordinations of *Stylosanthes* species with respect to

climatic attributes. In Cases 4—5. agronomic data are analysed by pattern analytical and statistical methods. Nutrient responses in *Stylosanthes* are elucidated by the help of principal coordinate analysis and incremental sum of squares classification in Case 6. In the following case electrophoretic data of *Stylosanthes* accessions are analysed using three classification techniques. The results of subjecting several sets of soil data to P.C.A. and factor analysis are presented in Case 8. We find here some examples of ordination of trace elements and soil types. Case 9. is a discussion of problems in numerical classification of soil data. Case 10 deals with some numerical models constructed for the analysis of soil profile data. Northern Australian climate types are compared using different methods in Case 11.

Tropical pasture types are classified and the resulting groups are described in Case 12. The extent to which the environmental and floristic attributes have contributed to this classification has been ascertained. Results of a pattern analytical study of nitrogen mineralization potentials of soil are presented in Case 13. Case 14. outlines the possibility of analysing three dimensional (locus × species × time) vegetation data. The classification is not made on the original data but on their variances. Sequential effects of grazing, burning and fertilizing on the botanical composition of a grassland community are also analysed (Case 15.). Ordination and classification methods indicated a similar pattern in the data. Results of the numerical analysis of the special gilgal vegetation are presented in Case 16.

Relationships between the efficiency of utilization of forage oats by sheep and the quantity of forage available are investigated by statistical and ordination methods. Case 20. is certainly a very interesting example for those taxonomists who deal with grasses. The author investigates the influence of attributes on the classification of 92 grass genera.

In the last case some recently developed multivariate methods are tested and compared.

All chapters and cases are followed by bibliographies. It is unfortunate, however, that some important works are entirely ignored. In spite of this, however, to the well-edited book will most certainly be welcomed by both agronomists and botanists.

J. PODANI

C.A.S. HALL and J. W. DAY, Jr. (editors): Ecosystem Modeling in Theory and Practice: An Introduction with Case Histories. WILEY and Sons, New York. 1977, pp. 684.

There is no doubt, new tools are needed for dealing with and solving the more and more urgent ecological problems of mankind. We must clearly foresee the nearer and further consequences of our past and present activities, both industrial and socio-economical. But this is impossible without a deeper insight into the "mechanism" and principles of natural and semi-natural ecological systems.

One of the most promising "new tools" of ecology is system modeling, its aspect, conception and methods (especially: computer simulation).

The past decade of systems ecology brought an accelerated development and extension of this field. We have several introductory books on it, containing a broad scale of practical applications ("case history") of this new "art".

Here again is a bright new hybrid of this kind, from WILEY (Interscience series).

The two editors' composition from theoretical aspects and practical application of ecological modeling is well-balanced and gives a profound basis for understanding the very nature and difficulties of model-building process; and at the same time it offers a great variety of exciting case studies.

The book contains 25 articles from 34 authors. We may find among the authors many well-known experts of ecological modeling (W. S. OVERTON, C. A. SHOEMAKER, H. T. ODUM, R. G. WIEGERT, C.A.S. HALL and others). Approximately one third of the authors and half of the case studies are engaged with aquatic systems: marine biology and pollution; estuarine, river, and spring ecosystems; fishery etc.

The work is appropriate for graduate students and — as a reference book — for teachers and scientists too. It is also very useful as a textbook for an introductory modeling course.

It is divided into four sections. The first section contains 8 introductory chapters on modeling theory and procedures. The reader may find in them a concise treatment of basic terms, ideas, principles; the presentation and definition of a unified symbolic notation for diagramatic demonstration of conceptual models used consequently throughout the whole volume. This section also contains several approaches and viewpoint on the main economical, energetical, financial, and juridical problems connected with ecological modeling and decision making based upon it.

Two excellent articles should be mentioned in more detail. W. S. OVERTON's chapter (A Strategy of Model Construction) is surely one of the best of the volume. It is a fundamental and very condensed methodological discussion of the model-building process and the principal ideas directing it.

C. A. SHOEMAKER's article (Mathematical Construction of Ecological Models) deals with the most delicate part of modeling: the "translation" of structure and relations of a conceptual model into the language of difference equations. It also discusses the different solution techniques, including numerical approximations, Monte Carlo simulation and optimization methods.

The next three sections (Chapters 9—25.) interpret case histories where models have been used to analyse natural systems, assess environmental impact, and design optimal, or at least better interactions between man and nature. Anyone of the chapters are an entity in themselves and they are arranged within each section more or less in order of increasing difficulty.

In many respects this book is as much about models as about ecosystems. Many of the chapters are based on the results of abundant field work. In most cases the backup data presented here is but a very small part of the total data base that was used to construct the models. The published sources of the data used are mostly given in the bibliographies.

The second section contains 4 case studies aimed primarily at the better understanding of natural systems (mixed decidious forest, salt marsh, lake, thermal spring), especially the cycling of essential elements: N, C, P in aquatic and transitional ecosystems.

The third section's six cases are centered on assessing the significance and role of environmental impacts on natural systems (particularly on marine, estuarine, and river ecosystems). One may find a very exciting chapter on the modification of biospheric productivity by the industrial activity of man — this is also a simulation study, of course.

The last section comprises seven chapters. Each of them is a positive contribution the successful practical application of this new "art" in decision making.

These examples (regional planning and water management, cost benefit analysis of a power plant, modeling and controlling of forest fires, pest management in agro-ecosystems, etc.) may convince the most sceptical reader: by the proper use of conceptions and methods of systems ecology, we can find the optimal solution for many environmental problems. It can be added furthermore, that presently we have no other tools equally efficient.

Finally, it should be mentioned that the whole volume is well-documented, carefully compiled supplied with author and subject index. It is again a high-level presentation both in content and presentation from WILEY.

Z. SZŐCS

ELTON, C. S.: The ecology of invasions by animals and plants. Science Paperbacks, published by CHAPMAN and HALL, London. pp. 181, 51 plates, 51 figs. 1977.

One of the most important and interesting problems in ecology is the behaviour of plant and animal populations. Behaviour is meant here in the widest sense of the word including balance, changes, history of the separate and coexisting populations, their interactions, etc. This field contains a great number of exciting questions, such as competition, population dynamics, stability of a population under given conditions, colonisation of islands or bare areas, the existence of pioneer populations and/or floral and faunal realms, etc. These examples represent only a batch of the set of possible questions.

It can be stated, that all problems in ecology have to do with populations of this or that living organisms. The major part of applied ecology is also connected with the behaviour of populations, e.g. outbreaks of noxious animal or plant species, spread of pests, epidemic diseases in which animals or plants play a part, etc.

From the great range of these problems the author deals with the invasion of animals and plants. As he writes, "In this book I have tried to bring together ideas from three different streams of thought with which I have been closely concerned during the last thirty years or so". These three streams of thought are faunal history, ecology and conservation.

We can say with a clear conscience, he managed to accomplish this difficult task in his book excellently. The book provides us with serious scientific material and food for thought. The statements and conclusions in it are supported by numerous examples. The distribution of the species is illustrated by maps, the species themselves by photographs and drawings. The book is written in a brilliant flowing style and may be regarded as a fundamental one in "classic" ecology. This proved by the five reprints of the first edition of 1958.

The volume consists of nine chapters, a reference list (containing nearly 300 items) as well as an index.

In Chapter 1 ("The invaders") we can find histories of species brought from one country into another and exploded in the new environment. One of the examples is the dispersion of the so-called chesnut blight, a lethal disease caused by a fungus *Endothia parasitica*. It was brought from Asia to the eastern United States in 1911. This fungus has a natural host *Castanea mollissima*) in Asia, where it does not harm this chesnut. But the eastern American species, *C. dentata* was killed by it.

Another example is the case of the European starling (*Sturnus vulgaris*) and the North American muskrat (*Ondatra zibethica*). The former was brought from Europe to the United States, the latter vice versa, about the beginning of the century and both exploded quickly in the new environment. In zoogeographical terms a purely Palaearctic species (the starling) and a purely Nearctic species (the muskrat) have become Holarctic within half a century.

The story of *Spartina townsendii* is very interesting, as well. It is a natural hybrid between the Palaearctic *S. maritima* and the Nearctic *S. alternifolia*. The latter was introduced in to England. The hybrid has also been planted in several places of the world, so it has become almost cosmopolitan by human activity.

The second Chapter is entitled "Wallace's Realms: the Archipelago of Continents". To understand the recent ecological balances in the world, it is necessary to study the past, too. In this chapter we get a short, but precise summary and pictures of the Wallace's Realms with their history.

In the next chapter ("The Invasion of Continents") the author writes about the invasion of the continents by plants and animals. In the last 150 years more and more species have spread from their natural "homes" to "new homes". This spreading was invasion-like in most cases. The invasions, as a result of accidental or deliberate introductions, most often came to lands cultivated or modified by human practice. Only to the United States nearly 200,000 species and varieties of plants have been introduced from all over the world in a relative short time, mostly for crops, garden ornament and forestry. If the species invading a land is a noxious one and explodes rapidly causing heavy damage, the way to eradicate it is to introduce its natural enemy from the native land. But this means the introduction of further species.

These processes tend to mix and make the six continental realms uniform, as the dispersion of wild species will be limited rather by their genetic characteristics and adaptability than by the "traditional" mechanical barriers, like mountains, seas, etc.

A great many examples of the above mentioned and other similar processes are discussed in this chapter, with illustrations.

Chapter 4 is devoted to "The Fate of Remote Islands". There are numerous small remote islands on the Globe, being far from the evolutionary centres of the continents. In the past very few, mostly accidental immigrants reached them. The appearance of man on these islands, and the increase in sea transport made the process of dispersion and immigration much easier and faster. The invaders may suppress and substitute the endemic species, as it is shown by a lot of examples.

"Changes in the Sea" is the topic of the fifth Chapter. In the case of seas changes in the distribution of species are still not of the same magnitude as in that of the land and freshwaters. But it does not mean that seas can be intact of these changes. Three kinds are of great importance: the digging of canals (such as Panama or Suez Canal); accidental transport on ships (the mat of sessile algae and animals grown on the bottom of the ships with mobile forms in it); and deliberate introductions (with several human goals, like fishery, etc.). These processes are supported with the recitals of several, known cases.

Chapter 6 is dealing with the problem "The Balance between Populations". If an invader comes to a new habitat it rarely meets optimal conditions for spreading. The new habitat has its own flora and fauna adapted well to their "home", utilising the possibilities given by this "home" to a greater or lesser extent. If there are unutilised possibilities, the invader may be successful, that is, if there are free niches which can be occupied. In this case penetration may take place without any noticeable disturbance or without extinction of the native species. To penetrate a well organized complex community is more difficult, than a simpler one. This is the explanation of the fact, why explosion of an invader occurs more frequently in cultivated or man-modified areas. Penetration may often be unsuccessful. The original community has a certain *ecological resistance*, the more stable the community is, the more stronger this resistance is. For a better understanding of these phenomena we must study the problem of competition between populations, since it seems to be the key of these processes.

Some questions of food-webs are discussed in Chapter 7 ("New Food-chains for Old"). The energy flows through a very complex network in the living world. This network consists

of a lot of the so-called food-chains of different length and coupled in various ways. But human demands often shorten these chains, to reduce their number or the number of their members, or to substitute some of the members. Sometimes the demand is to lengthen the chain or to introduce a side-chain. We need plants without "other" herbivorous concurrents except us, and plants with a higher production than the native ones. These are the cases of shortening and changing the food-chain. Such profundal change is the replacing of the native grazing animals by domestic ones, e.g. in Australia the kangaroo by sheep, or the eradication of the bisons in North America. In contrast to these the limitation or eradication of a noxious invader need the introduction of its native counterpest or predator, that is, to lengthen the chain. This has also the advantage that there is selection which cannot be stated in the case of the chemical means.

In the last two chapters the author deals with the very important problem of conservation ("The Reason for Conservation" and "The Conservation of Variety", Chapter 8 and Chapter 9 respectively). Human activity has increased to an enormous degree and with enormous speed in the last 150 years. It has led to considerable changes in the world of living organisms. The dispersion of plants and animals has been strongly modified, thousands and thousands of species have become extinct completely within this period. The reader may find good enough examples of these processes in the previous chapters. *But man is also part of the living world, is tied to nature and it is impossible to live without it. This fact must not be neglected and cannot be emphasized enough.*

The reasons and some possibilities of conservation of variety in the living world are discussed in the last two chapters. We are obliged to maintain and preserve this variety for posterity to enjoy and to make use of it. As the author writes: ". . . And although there is a Law of the Conservation of Matter, there is no Law of the Conservation of Species.", and ". . . looking for some wise principle of co-existence between man and nature, even if it has to be a modified kind of man and a modified kind of nature. This is what I understand by *Conservation*." These words were very true at the time of the first edition in 1958, too, and are of much greater truth in recent days considering that the processes of pollution have taken place all over the world since 1958.

J. N. NOSEK

PATTEN, B. C. (ed.) (1975, 1976): Systems analysis and simulation in ecology Vols III.—IV. Academic Press, New York 601 pp, 593 pp

The general characteristics of the volumes (construction, arrangement, references, etc.) are identical with that of the first two, so for lack of space they will not be repeated. They are to be found in the first part of the review of the first two volumes (see preceding review, in Acta Botanica 23 (3—4)).

These two volumes contain the matter of a symposium "Modeling and Analysis of Ecosystems" held during March 1—3, 1973 at the University of Georgia. They are not "Proceedings" in the usual sense. They contain additional chapters on topics not held at the conference, and others were revised.

Volume III.

It consists of two sections (Part I. "Ecosystem Modeling in the U.S. International Biological Program"; Part II. "Models of Freshwater-Estuarine Ecosystems") containing 7 and 5 chapters, respectively.

Part I.

Chapter 1 an introduction to Biome Modeling. The author gives a review on the historical development of U.S. I.B.P.

Chapter 2 is deals with the Grassland Biome study. It reviews the succession of the models until the most appropriate — the ELM — a total system model was developed, including the developing of a suitable language (SIMCOMP). It is followed by the discussion of some specific philosophical problems which emerged during the model building (e.g. the problem of linearity — non-linearity, determinism — its alternates, languages — communication, etc.). The ELM model has five main compartments: abiotic, nutrients, producers, consumers and decomposers. The abiotic submodel concerns flow of water and heat; the nutrient one treats phosphorus and nitrogen dynamics. The producer submodel represents biomass dynamics of

five plant categories: warm season grasses, cold season grasses, forbs, shrubs and cacti. The flows between and within the three biotic compartments are governed by the abiotic sector (heat, water) and influenced by nitrogen and phosphorus. Attention to phenology is a significant feature of this model. The consumer submodel is limited to one animal, the cow (*Bos taurus*) in the original ELM model. A model of grasshopper dynamics and bioenergetics has also been developed, and will be incorporated into the ELM structure. The decomposer section is partitioned into several vertical soil layers, each of them subdivided into a hard and a soft component. The two components differ from each other in the speed of decomposition. The model is seen to be successful in solving the problems raised at the beginning of the study. The modeling efforts directed attention to many unknown aspects of grassland ecology. Further work on ELM is intended to extend its validity to other types of grasslands than the short grass praire.

Chapter 3 describes progress in ecosystem modeling in the Eastern Deciduous Forest Biome. It presents an overview of the scope and direction of modeling projects within the Biome program. This scope is documented by a tabulation of 71 models completed, in progress or soon to be initiated. The author touches on a lot of questions, e.g. program management, program objectives, model integration, progress modeling, the progress compared to expectations, the interaction of modeling and field research, how this modifies the ecologists' approach to science, etc. Methods of ecosystem analysis by the examination of ecosystem models is seen to be one of the most fertile areas for future system research.

In Chapter 4 the author refers to approaches to modeling in the Desert Biome. He emphasizes the role of prediction. The aim of this modeling also was, to develop techniques for predicting changes in arid land ecosystems. He views ecosystem dynamics as a succession of transients, nothing resembling a steady state every being attained. The emphasis on prediction is not only the one modeling objective possible, but it is the one emphasized here.

Chapter 5 contains the development of ecosystem modeling in the Tundra Biome program with the aim of making prediction and to understand the tundra as an ecosystem. First the investigations were focused on the wet coastal tundra of the Arctic North Slope, near Barrow. They brought basic environmental knowledge on the specific problems of ecosystems having the cold as the most important regulating factor. The Barrow ecosystem is seen as a simple one with about 100 species of vascular plants, the lemming as the only major herbivore and fewer than ten predators. Later on the research was expanded to a geographically wider base, and broader models were constructed. Terrestrial and aquatic models were developed. They are constructed to accept mechanistic models at different levels of refinement. Low species diversity and ecosystem simplicity made it possible to consider individual species in many cases.

In Chapter 6 the author describes the work of developing a whole system model for the Coniferous Forest Biome. First he deals with the basic problems of model building theoretically. He suggests in ecosystem modeling it is not sufficient to model parts and such models cannot be coupled to a model of the whole. Each system and subsystem would be considered as a holon ("holon" does mean after KOESTLER (1967) "a potential subsystem of a greater system, and simultaneously a coupled collection of lesser subsystems"). The holism is what is to be captured, and the holistic properties are not apparent from study of the parts. He emphasizes that the mechanistic models are not appropriate in modeling large ecosystems. He suggests that each system should be conceptualized and modeled both holistically and mechanistically. A clear distinction is essential between modeling and programming. The chapter also contains some operational aspects of modeling in the Coniferous Biome.

Chapter 7 contains a critical evaluation of the U.S. I.B.P. Biome modeling program, touching upon the major problems briefly.

Part II.

The chapters of Part II. deal with models of aquatic ecosystems, with freshwater-estuarine ones.

Chapter 8 presents models of the algal-fly component of a simple ecosystem in thermal effluents at Yellowstone. Five models are examined. Three of them have identical trophic structure — representing the maximal complexity needed for realistic simulation —, the other two have progressively simplified trophic structure. The filamentous blue-green algae grow in the effluents. The growth of the algal mat disturbs the original laminar water flow, so various sites are produced different both in drift speed and temperature. So the occurrence of the brine-fly is also mosaic-like. The adult flies, eggs and larval instars are parasitized by several animals, and have a lot of predators. The central problem of the model is the energy flow.

Chapter 9 describes ecosystem modeling applied to small woodland streams. First the general ecology of a woodland stream is described followed by the system model. The author

emphasizes the importance of developing experimental and theoretical approaches side by side. The model was refined by iterative interactions between system scientists and stream ecologists.

Chapter 10 contains the work of 41 authors, who constructed a total ecosystem model for a small cove in Lake Texoma, Texas-Oklahoma. The model is essentially linear. It has five submodels: primary producers, zooplankton, benthic invertebrates, vertebrates and decomposers. Several morphometric and abiotic factors are also included (e.g. substrate, temperature, solar radiation, wind and currents, rain, water level, nitrogen, phosphorus, dissolved carbondioxid, etc.). The effects of small perturbations through simulation, such as thermal pollution, eutrophication, etc. were examined here.

In Chapter 11 the authors describe a preliminary phytoplankton–zooplankton–nutrient model. Their reason for constructing the model is applied: to aid in understanding, management and control of eutrophication.

The final (Chapter 12) is about an example of water resources modeling. The basis of water resources management is to know the aquatic ecosystem. The Law of Mass Conservation and the Kinetic Principle are the two principles underlying model construction. The ecosystem is defined by masses of phyto-, zoo plankton, fish, benthos, detritus, and measures of water quality constituents, such as temperature, BOD, dissolved oxygen and nutrients. These masses are defined or determined for all the hydraulic elements. The ecology in the model is not as comprehensive as in e.g. the Lake Texoma cove model (Ch. 10), but a combination of the two approaches (that is the ecological and hydraulical ones). There are two versions of the model, a lacustrine one and an estuarine one applied to Lake Washing ton andto San Francisco Bay Delta, respectively.

Volume IV.

It contains 17 chapters divided into five sections.

Part I.

The first part consists of three chapters dealing with the models of estuarine-marine ecosystems, so it is closely connected with Part II. in Vol. III.

The first chapter presents a model of the Delaware Estuary. This model is a part of the regional management model of the lower Delaware Valley.

In the second chapter the author investigates the nitrogen and phosphorus productivity of the Peru upwelling ecosystem. C/N ratios predicted by the model corresponded to the observed values well, so it could be suggested that the ecosystem investigated (within 40 km of the coast) may be regulated by silicate and phytoplankton intrinsic growth rates.

Chapter 3 is a simulation of the flow of biologically limiting nutrients through marine trophic levels over the continental shelf of West Florida. The weakness of the model is due to the extreme abstraction and/or negligences.

Part II.

It also contains three chapters, which deal with terrestrial ecosystems.

Chapter 4 presents a model of mangrove ecosystems in South Florida. It concerns the role of mangrove, the effects of mangrove on nutrients in water, on detritus export and accumulation and vice-versa, as well as the effect of tidal flushing.

In Chapter 5 the author studies the effects of perturbations on forests manifest in the growth of individual trees. The basis was the forest simulation model, JABOWA developed earlier. Perturbation was investigated at equilibrium, approaching equilibrium and at the beginning of the secondary succession. Perturbations that reduce tree growth, tend to favour shade-intolerant species, while others that increase tree growth, tend to favour shade-tolerant species.

Chapter 6 describes a model of the *Liriodendron tulipifera* dominated forest ecosystem. The physiological mechanism responsible for production, distribution and decomposition of organic matter was investigated. The behavior of the model was studied under a variety of quiescent and disturbed conditions.

Part III.

The three chapters of this section are devoted to "human ecosystems", to modeling 3 cosystems with man in the focus.

Chapter 7 deals with the problem, how industrialized man relates to natural environment. Problems of technological planning and regional economic development are presented in a cybernetic perspective to identify states to be avoided and means of avoiding them.

Chapter 8 is an essay on the world models "World Dynamics" and "The Limits to Growth", the projects of the Club of Rome.

In the last chapter of this section (Chapter 9) the author outlines the so-called "macroscopic-minimodels", models that are macroscopic in viewpoint, but minidimensional in complexity. A number of various analog computer simulated models are described for illustration, such as money–energy, producer–comsumer symbiosis and competition, recycling and mining, power titration with war, order and disorder, regional development optima, succession with declining energy reserves, etc.

Part IV.

It deals with the special problems in ecosystem modeling containing three chapters. Three basic problems are examined. They are linearity versus non-linearity, aggregation and validation (in Chapter 10, 11 and 12, respectively).

Part V.

The final section contains five chapters concerned with theoretical aspects of ecosystems.

Chapter 13 treats the applicability of engineering system analysis procedure to ecosystem studies. Time domain, frequency response, stability and sensitivity analysis are examined.

In Chapter 14 the adaptability of optimal control theory for problems of ecosystem regulation is discussed. A method is presented for controlling large systems with a relatively small number of parameters or inputs.

In Chapter 15 the sensitivity analysis introduced in Chapter 13 is further elaborated. Sensitivity is the difference in behaviour between a perturbated and unperturbated system. Relationship of sensitivity to the concept of stability is also investigated.

Chapter 16 concerns patterns of biological control in ecosystems. Control mechanisms are manifested at different levels of organization. The different control patterns within populations interlock with each other and with control processes at higher levels to regulate the ecosystem as a whole.

The final chapter (Chapter 17) presents a causal model of the organism-environment relation. The causal bond (cause-effect) is modeled as an abstract input-output object called a holon (the term "holon" does not mean the same here, as in the Ch. 6 in Vol. III.). The input and output are recognized as a distinct object called creanon and genon respectively. Each defines a unique, a specific environment. The genon has a generative and productive role in transforming cause into effects. The creanon serves a creative or selective function in defining object-environment consistency and compatibility. These two aspects of the holon are investigated from the point of view of causal determinism, causal bond and causal sequences. The study is illustrated by a lot of examples of small ecosystem models.

As it was pointed out in the introductory lines (see in preceding review), the four volumes contain a lot of studies different in themes, stage of development, theoretical fundamentals, difficulty, etc. The volumes give an excellent and comprehensive cross section of the current scope and state of system ecology. So they are very useful for ecologists, botanists, zoologists, system scientists and for everybody, who is interested in this topic.

J. N. Nosek

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НАЛИЧИЕ ВОДЫ И ЗАСУХОУСТОЙЧИВОСТЬ ВИДОВ SESELI LEUCOSPERMUM И S. OSSEUM В ГОРИСТОЙ МЕСТНОСТИ БАЛАТОНА

Л. АЛМАДИ

У эндемического вида *Seseli leucospermum (Apiaceae)* сублетальная нехватка воды колебалась между 60—68%.

Путь актуальной нехватки воды у этого вида указывает на то, что в случае удовлетворительного снабжения водой значения дефисита воды остаются между 3—12%. В случае высыхания почвы оценка дефицита воды более высокая.

Вид очень интенсивно траспирирует. В случае хорошего снабжения водой можно наблюдать двухверхушечную ежедневную транспирацию. В сухое время года транспирация уменьшается (предельная оценка 4,4%).

У вида *Seseli osseum* сублетальный дефицит воды находится в пределах 72—77% и он является засухоустойчивым видом. Годовые и ежедневные пути актуальной нехватки воды этого вида показывают, что по количественным оценкам он всегда превосходит предыдущий вид, произрастающий в похожих условиях. Данные колеблются между 10—50%, в которых высшие оценки возникают в результате засухи.

Вид интенсивно транспирирует. В случае хорошего снабжения водой ежедневный ход транспирации остается более или менее в соотношении с эвапорацией. На высыхающей почве, в случае плохого снабжения водой транспирация мельчает. Этот вид способен на эффективное снижение транспирации.

КСИЛОТОМИЧЕСКИЕ ИССЛЕДОВАНИЯ НЕКОТОРЫХ ДРЕВЕСНЫХ ВИДОВ КУБЫ 1

К. БАБОШ И А. БОРХИДИ

Статья является продолжением работы «Ксилотемические исследования кубинских пород древесины», начатой в 1976 году. В данной работе авторы знакомят с важнейшими анатомическими показателями ксила восьми кубинских пород древесины.: ***Garrya fadyenii* Hook.** (Copnaceae), ***Catalpa punctata* Griseb.** *(Bignoiaceae)*, ***Tabebuia lepidota* (HBK.) Britt** *(Bignoniaceae)*, ***Pera bumeliaefolia* Griseb.** *(Euphorbiaceae)*, ***Trichilia hirta* L.** *(Meliaceae)*, ***Guarea Guidonia* (L.) Sleumer** *(Meliaceae)*, ***Cupania glabra* Sw.** *(Sapindaceae)*, ***Calophyllum antillanum* Britt.** *(Clusiaceae)*

ЭКОЛОГИЧЕСКИЙ ФАКТОР — ПРИСПОСОБЛЕННОСТЬ — НА ОСНОВЕ ИЗУЧЕНИЯ ВЗАИМОСВЯЗИ ПРОДУКЦИИ СТЕРОИДНОГО АЛКАЛОИДА У ДВУХ ВИДОВ

Solanum laciniatum Ait. и Solanum dulcamara L

Я. БЕРНАТ, Р. ТЕТЕНЬИ

Авторы с новой точки зрения освещают вопросы по образованию и накоплению вторичных продуктов обмена веществ, на протяжении десяти лет, в фитотроне, вегетативном сосуде, на микроделянках и на маленьких делянках. Авторы доказывают, что в слу-

чае гомологического образования подобного вторичного продукта (в данном случае стероидного алкалоида) нужно обращать внимание на экологическую приспособленность исследованного вида, а также нужно оценивать изменения комплексно, последовательно следя за ростомразвитием. Изменение общей продукции алкалоидов может произойти независимо от вида, непосредственно через изменение уровня-агента органов, а также с изменением продуктивного отношения уровней агентов и с влиянием общей продукции сухого вещества (и в случаях соотношения органов и неизмененного отчасти уровня агента). Большие различия в продукции алколоидов показывает морфо- фенологически менее приспособленный хелиофитный вид ***S. laciniatum.*** Так в отличии от убиквентного вида ***S. dulcamara*** образование агликона (соласодина) у этого вида в зависимости от интенсивности света показывают различия в 10—12 раз, а в зависимости от температуры воздуха воды, почты и снабжения питательными продуктами показывает 50—100% различие. Соответственно этому, вместо экологического фактора — влияние алколоидной продукции — целесообразно говорить о экологическом факторе-типе алкалоида и вида, а также о зависящей от экотипа первичной реакции.

ЦЕЛЛУЛАРНОЕ СТРОЕНИЕ КЛЕТОЧНОЙ ОБОЛОЧКИ ГАМЕТОФИТА MARCHANTIA POLYMORPHA L.

Л. ФРИДВАЛСКИЙ, И. ДЕМЕТЕР–СИЛАДЬИ

Авторы изучали строение целлулазной клеточной оболочки клеток паренхимы, богатой хлоропластами а также паренхимы с угловатыми клетками у колонии гаметофита *Marchantia polymorpha* L. Между этими типами клеток главное отличие проявлялось в форме, величине а также в суб- или световом микроскопическом строении целлулазного остова их клеточной оболочки. Из этого можно сделать вывод, что их функции тоже различаются и это значит что их физиологическое различие отражается в особенности строения клеточной оболочки. В богатой хлоропластами паренхиме, внутри тех же самых клеток, авторы выявили два различных строения оболочки, это обозначает, что оболочки этих клеток дифференцировались соответственно их функциям. Значительное различие оболочек угловатых клеток паренхимы проявляется в их местоположении в колонии. Как и клетки паренхимы богатой хлоропластами, так и угловатые клетки паренхимы достигли в развитой стадии их характерных размеров, считая от растущей верхушки колонии на растоянии внутри 3000 микрометров.

Образование характерного утолщения формы угловатых клеток паренхимы удалось заметить внутри расстояния 600 микрометров от верхушки, когда длина развитых клеток достигла только одной трети. Эта форма уже проявилась на расстоянии 1300 микрометров, т. е. еще до полного развития величины клеток. У обоих типов клеток микрофибриллы некоторых клеточных оболочек распологались перпендикулярно по напрявлению роста длины колонии.

СПОРОМОРФЫ АНГОЛЫ НА БУРОКАМЕННОМ УГЛЕ

М. КЕДВЕШ, П. ШИМОНЧИЧ

Авторы, производя палинологическую обработку образцов угля, собранных в Анголе, в долине реки **Lungue Bungo**, нашли 36 спороморфов. Описаны как новые ***Angolaepollenites umbelliferoides*** **n. fgen. et. n. fsp.**, ***Cyperaceaepollis angolaensis*** **n. fsp.** и ***Cyperaceaepollis africanus*** **n. fsp.**

При описании спороморфов авторы произвели 2 **fsp.** исследования при помощи СЭМ. На основании спороморфов опознали 22 рецентных таксона и из этих могли определить 14 до семейства, 2 до подсемейства, 3 до рода и 3 до вида.

Болото в котором образовался уголь было ***Cyperus papyrus.*** Сюда попала пыльца из травяной саванны, которая была богата ***Compositae,*** из окружаещего леса и болотного карликого растения, произрастающего на скалистой почве, а также из дальнего леса ***Podocarpus.***

На этой территории во время образования угольного болота возможно выпадало больше осадков, чем в настоящее время. Время её происхождения авторы относят на границу высшего **tercier-kvarter** или нижнего **kvarter.**

ВЛИЯНИЕ ОБРАБОТКИ ХОЛОДОМ НА ИЗОЗИМЫ ИУК-ОКСИДАЗЫ В РАЗЛИЧНЫХ МОРОЗОУСТОЙЧИВЫХ СОРТАХ ОЗИМОЙ ПШЕНИЦЫ

И. КОВАЧ, О. ФЕЙЕР, М. ДЕВАИ

Авторы изучали связь между интенсивностью роста и морозо-устойчивостью у различных морозоустойчивых сортов пшеницы. На основе полученных данных авторы пришли к выводу, что между интенсивностью роста и морозоустойчивостью различных сортов морозоустойчивых пшениц существует тесная негативная корреляция. Этот вывод подтверждает то, что принимающая участие в регуляции роста оксидаза индол-триуксусной кислоты активно возрастает при низкой температуре а также под влиянием холода происходит синтез ензимов «de novo». Результаты показывают, то что система оксидазы – ИУК способна на температурную адаптацию морозоустойчивых сортов пшеницы. Механизм адаптации связан с комплексными процессами и требует дальнейших исследований.

АККУМУЛЯЦИЯ-ЭЛЕМЕНТОВ БАЛАТОНСКОГО ТРОСТНИКА (PHRAGMITES COMMUNIS)

М. КОВАЧ, И. ПРЕЧЕНЬИ, Я. ПОДАНИ

В прибрежной зоне Балатона авторы исследовали количество полиэлементов (N, P, Ca, K, Mg, Na, Fe) и олигоэлементов (Mn, Zn, Sr, Cu, Pb) у тростника в стеблях, листьях, ризомах, корнях и корневых волосках (включая также волосистые дополнительные корни). На основании процентов сухого материала среди исследованных частей полиэлементы накапливаются в листьях и в волосках корней) включая дополнительные корни) в уменьшающемся количественном порядке: корень ризома и стебель, в случае олигоэлементов порядок следующий: корневые волоски (дополнительные корни), корни, листья и в конце ризома и стебель. Ризома и стебель тростника, вернее корни и волоски корней в похожем количестве и пропорции содержат накопленные элементы.

Лист- принимая во внимание абсолютное количество материала-отличается от других органов в большой степени, а принимая во внимание пропорции, в первую очередь похож на стебель.

ИЗУЧЕНИЕ АФРИКАНСКИХ CALYMPERACEAE II

Ш. ОРБАН

Автор дает описание и распространение нового вида ***Syrrhopodon usambaricus*** **Broth. ex Orbán**. Автор описывает местонахождение *S. brevivaginans* **Demar. et Leroy** и *S. linealis* **Dix. et Thér.** в Восточной Африке, а также местонахождение *S. mauritianus* **C. Müll. ex-Aongstr.** в Восточной Африке и на Мадагаскаре. Автор выясняет номенклатурную проблему *S. glaucovirens* **Mitt. var.** *rufus* **Ren. et Card.** определяя, что выше названное **nome nudum** и синоним таксона *S. glaucophyllus* **Ren. et Card. var.** *rufus* **Ren. et Card.**

МЕТОД АНАЛИЗА БИНАРНЫХ (ФЛОРИСТИЧЕСКИХ) ДАННЫХ В ИЗУЧЕНИИ ВЕГЕТАЦИИ

Я. ПОДАНИ

В статье предлагается новый индэкс для определения локального, вернее флористического сходства, который принимался во внимание в соответствии с важностью аттрибутов. Применение этого индэкса в так называемом методе «**centroid sorting**» демонстрируется на одном гипотезном и одном конкретном примере. В статье излагаются также результаты анализа скалисто-травяного сообщества.

ТИПЫ ПРИИСКОВ ВЕНГЕРСКИХ ЛЕСНЫХ СООБЩЕСТВ

И. СОДФРИДТ

На основании подробных полевых работ, которые были проведены на 1500 местах, и которые относятся к отдельным сообществам, автор, используя литературу по растительным сообществам, разработал таблицы в которых выделил отношения между венгерскими лесными сообществами и приисками. Определение типа прииска основано на работе З. Яро (1972). Соответственно этому автор разработал шкалу оценки факторов для характеристики типов приисков: климат, гидрология, тип почвы, глубина обработанной почвы. Автор на

основе монографии Шоо (1964—1973) обсуждает лесные сообщества, а мало распространенные лесные сообщества, автор пропускает.

ФУНКЦИОНАЛЬНОЕ СОСТОЯНИЕ ФОТОСИНТЕТИЧЕСКОГО АППАРАТА МОРСКОЙ ЗЕЛЁНОЙ ВОДОРОСЛИ ULVA FENESTRATA ПО ХОДУ ДНЯ

Э. А. ТИТЛЯНОВ, П. В. КОЛМАНОВ, Б. Д. ЛЕЕ, И. ХОРВАТ

В структуре и функции фотосинтетического аппарата морской зелёной водоросли *Ulva fenestrata* нашли сигнификаное различие по ходу дня. В утрение часы оптическая плотность и количество пигментов колоний водоросли возрастают. Хлоропласты сдвинутся от внутренних стенок клетки в сторону наружных, фотосинтетический потенциал повышается. В послеполуденные часы можно обнаруживать обратное изменение. Можно сделать такой вывод, что изменения в хлоропластах *Ulva fenestrata* находятся и под контролом эндогенной регуляции, так как "интенсивность" этих процессов во время дня зависит от световых условиях.

ХЕМОТАКСОНОМИЧЕСКОЕ ДОКАЗАТЕЛЬСТВО МЕСТА В СИСТЕМАТИКЕ KICKXIA ELATINE (L.) DUM. И KICKXIA SPURIA (L.) DUM.

А. ТОТ, И. ЧОРДАШ, В. ПАПАИ

Авторы изучали химический состав ***K. elatine*** и ***K. spuria*** На основании химических свойств авторы сделали вывод о месте рода в систематике и о степени развития внутри семейства в процессе филогенеза. Авторы определили, что среди углеводов в роде ***Kickxia*** встречается маннитол и миоинозитол характерный для семейства. Среди иридоидов в видах ***Kickxia*** встречаются характерные для трибы ***Antirrhineae*** антирхинозиды и линариозиды. Характерности рода, которые отличают их от других родов трибы- это флавоноиды: 5, 6, 7 триметаксифлавон, и два тригидрокси-диметокси флавон глюкозид. Соответственно этому, химические свойства и морфологические признаки доказывают, что род ***Kickxia*** относящийся к трибе ***Antirrhineae*** а и внутри семейства самый развитый род.

КОРОТКО-ПЕРИОДИЧНЫЕ ИССЛЕДОВАНИЯ ФИТОПЛАНКТОНА БАЛАТОНА

Г. Л. ТОТ, Ю. ПАДИШАК

Авторы исследовали в 1976 году с 20 июля по 18 августа ежедневно количество особей и биомассу фитопланктона Балатона, отдельно макро- и микро-водоросли, а также органическо-угольное содержание, температуру и прозрачность воды. Подобные исследования на Балатоне еще не проводились.

Динамика некоторых измеренных переменных величин отражает характер мелководности озера. Полученные авторами данные обращают внимание на различие между изменениями макро- и микроводорослей за тридцать дней, а также указывает на различия внутри продолжительности информации множественных переменных- количества особей и биомассы. Содержание неорганического угля и некоторые другие данные указывают на прогресс эутрофизации озера.

ИЗМЕНЕНИЕ ФРАКЦИЙ БЕЛКОВ И СОДЕРЖАНИЯ ВОЛОКНА В ОГРОМНОМ БУРОМ МОРЩИНИСТОМ КОЛЬЦЕВОМ ГРИБЕ (STROPHARIA RUGOSOANNULATA FARLOW EX MURR.) В ПРОЦЕССЕ РАЗВИТИЯ ПЛОДОВОГО ТЕЛА

Я. ВЕТТЕР, И. РИМОЦИ

Грибы относятся к растениям с высоким содержанием белка. Наряду с некоторыми культивированными видами (***Agaricus bisporus, Pleurotus ostreatus***) важная задача разводить новые виды и к этому необходимы опыты по физиологии и культивации этих видов. Так например, имеется недостаточная информация о том, как изменяются показатели внутреннего содержимого, среди этих главным образом количество и соотношение различных фракций белков, а также содержание волокон в процессе развития плодового тела. С этой целью авторы провели серию опытов с двумя сортами большого бурого гриба (*S. rugosoannulata*). В этой статье авторы дают отчет о результатах этих опытов.

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XYLOTOMIC STUDY OF SOME WOODY PLANT SPECIES FROM CUBA, II

By

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(Received 15. December, 1977)

The authors describe the most important anatomical features of the xylem, external morphology, occurrence and habitat of eight woody species of the Flora of Cuba, namely: *Curatella americana* L. (*Dilleniaceae*), *Luehea speciosa* Willd. (*Tiliaceae*), *Alvaradoa amorphoides* Liebm. ssp. *psilophylla* (Urb.) Cronq. (*Simarubaceae*), *Cyrilla racemiflora* L. (*Cyrillaceae*), *Lysiloma bahamensis* Benth. (*Mimosaceae*), *Myrsine cubana* A. DC. (*Myrsinaceae*), *Mastichodendron foetidissimum* (Jacq.) Cronquist (*Sapotaceae*), *Linociera bumelioides* Griseb. (*Oleaceae*).

Materials and methods

Blocks of the different woods were softened (2—3 atm., in the 1 : 1 mixture of water-glycerine in an J. BRINZER autoclave, then cross, tangential and radial sections were obtained. The sections were dyed in an alcoholic solution of the microdyestuff of Toluidin blue. The maceration of the xylem was performed by the SCHULZE's method (SÁRKÁNY—SZALAI 1964). Length of the fibers and vessel elements, tangential and radial diameters of the vessels, width and height of the medullary rays, and other features were measured. Minimum-maximum values for each anatomic feature of individual species were calculated from 50—100 measurements.

Suitably enlarged microphotographs were prepared of each section.

External morphology, distribution and ecology

Curatella americana L.

Shrub or little tree up to 6—8 mm height. Leaves ovate or elliptic-ovate, 12—30 cm long, rounded and emargined at the apex, rounded to decurrent at the base; blades scabrous on both surfaces, margin sinuate-undate, coriaceous. Flowers fragrant, white; sepals 4—5, petals 5—6 mm long, filaments thickened at the apex, anthers oblong. Ovary apocarpic, carpels 2, biovulate, globose when mature, hirsute, 6—7 mm long. Seeds black, enclosed in a membranous arilus.

This species is widely distributed all over the neotropic regions; it is a common and well-known savanna-shrub. In Cuba it occurs on shallow, mostly sandy soils generally poor in nutrients; lives in pine-woodland, evergreen-oak-forests and secondary savannas in the provinces of Pinar del Rio, Habana, Matanzas, Camagüey and in the Isle of Pine.

Luehea speciosa Willd.

Tree up to 20—25 mm height. Bark smooth, gray; branches densely tomentose by ferrugineous stellate-hairs. Leaves soft, deciduous, elliptic to ovate or elliptic-ovate, 10—20 cm long, abruptly acuminate at the apex, rounded or cordate at the base; blades stellate-

scabrous above, pale tomentose beneath, serrulate at the margin. Flowers white, bracteoles 1.5 cm long; calyx densely tomentose, 1.5 cm long, petals white, 2.5—4 cm long, with 5 glands at the base; stamens numerous, obscurely connate into 5—10 fascicles, the exterior ones without anthers. Ovary 5-locular, cavities multi-ovulate, style simple, stigma capitate and obscurely 5-lobulate; capsule lignose, 3—4 cm long, brown-tomentose, obtusely 5-angulate, dehiscent at the apex. Seeds imbricate, testa prolonged into a wing, endosperm fleshy.

This species has a neotropical distribution pattern. In the Antilles it does not occur except West-Cuba, in the provinces Pinar del Rio, Habana, Matanzas, Las Villas and Isle of Pine. It is a rather common tree in the first canopy layer of the lowland and submontane seasonal evergreen tropical forests, growing mostly on tropical brown, yellowish-red and red soils derived from different rocks.

Alvaradoa amorphoides Liebm. ssp. *psilophylla* (Urb.) Cronq.

Shrub or tree up to 15—20 m height. Leaves imparipinnate, alternate, leaflets 18—50, alternate, oblong-elliptic, somewhat acute at the apex, 1—3.5 cm long and 4—12 mm wide, blades bright-green above, strigillous-hirsute beneath. Flowers dioic in axilar or subterminal racemes. Sepals of the male flowers ovate, 1—2 mm long, somewhat united at the base; petals linear-filiform 2—2.5 mm long. Stamens 5, filaments 3—5 mm long, inserted in the lobes of the disc, absent in the female flowers. Ovary 2—3-locular with an only fertile carpel; ovulas 2, carpels pulvinate-puberulent. Fruit samaroide, winged, lanceolate or lanceolate-ovate, 8—18 mm long, margin ciliate; seed 1.

This subspecies has a North-Caribbean distribution pattern occurring all over Cuba, in the Bahamas and Florida (United States). It grows in the littoral and semideciduous forests as a rather frequent element of the first canopy layer, sometimes as an emergent tree. From an ecological point of view it is in the littoral dog-tooth areas further on shallow limestone rendzinas and protorendzinas, less frequently on tropical brown soils and red latosolic soils, mainly in the lowland and submontane regions up to 400—500 m above the sea evel.

Cyrilla racemiflora L.

Shrubs or trees up to 15—20 m height. Leaves elliptic, oblong-elliptic, obovate or oblanceolate, 3—12 cm long and 6—30 mm wide, attenuate at the base, attenuate, obtuse or rounded, sometimes retuse and mucronulate at the apex; blades glabrous, shiny, nerves prominulous and densely reticulate-veined on both surfaces, coriaceous. Flowers white, numerous in a dense raceme, inflorescence mostly longer than the leaves; pedicels 2—4 mm long, calyx 5-lobulate to the base, 1 mm long, lobes acuminate; petals 5, acute 2 mm long; stamens 5, filaments free, subulate, adnate to the corolla; connective apiculate, dehiscent by an apical porus. Ovary oblong, 2-locular, style short, obconic, stigma 2-lobulate, ovules 1—3 in each cavity, pendulous; fruit a 2—3 mm long, ovoide, capsule 2-locular, seed 1 in each cavity.

An extremely polymorphic species as for the form and shape of leaves and length of inflorescence. Therefore THOMAS (1960) united all the Antillean *Cyrilla*-species into an only species (*C. racemiflora* L. sensu latissimo) and did not separate any subspecific taxon on a morphological basis. As to our opinion (s. BORHIDI and MUÑIZ 1971) *C. racemiflora* sensu Thomas non L. is a collective species or an agglomeration of very closely related and valid species. The specimen studied in this paper belongs to the real *C. racemiflora* L. s. str. A thorough taxonomic revision of this species is still needed.

This species has a Caribbean distribution pattern occurring in the Southern United States, in Central America, the Northern part of South America and in the Antilles. In Cuba it can be found in the Western part of the country (Pinar del Rio province and Isle of Pine). It is reported also from the Sierra Maestra range (Oriente province), but that population only doubtfully belongs to this species. As for its ecological pattern in West-Cuba, it occurs in the

lower hills and submontane regions between 20—700 m above sea level. It lives mostly in pine woodlands on siliceous sandy soils and on shallow yellowish-red pseudopodsols derived from sandstone rocks, associated with *Pinus caribaea* Morelet, *Vaccinium cubense* (A. Rich.) Griseb. ssp. *ramoniana* (Griseb.) Borhidi, *Rondeletia correifolia* Griseb., etc.; it is also frequent in pine forests on serpentine-latosols associated with *Pinus caribaea*, *Psidium cymosum* Urb., *Tetrazygia coriacea* Urb., etc., furthermore, it is a subdominant tree in the first canopy layer of the riverside evergreen tropical forests associated with the "Manaca palms", *Calyptrogyne intermedia* and *C. dulcis*, and in the montane rain forests.

Lysiloma bahamensis Benth.

Tree up to 20—25 m height. Bark smooth, gray; stipules ovate, acuminate. Leaves large, paripinnate, petiole 1—3 mm long with a thick gland, 2—5 pairs of pinnae, leaflets 10—33 pairs, oblong, membranous, pale green, 8—15 mm long, puberulent. Inflorescences composed racemous, axillar, or terminal; flowers capitate globose, peduncles generally 1—1.5 cm long; calyx campanulate 5-merous, 1—1.5 mm long; corolla funnelform, white or bluish-white, 2—2.5 mm long, pilose, lobes valvate. Stamens numerous, much exerted, tube of filaments short. Ovary multiovulate, style stout, thin. Pods straight, erect, linear or linear-oblong, 2—5 cm wide, acuminate, complanate, dehiscent marginally. Seeds compressed, about 12 mm wide.

This species has a North-Caribbean distribution pattern, occurring in the Yucatan Peninsule, all over the territory of Cuba and Isle of Pine, in the Bahamas and Florida (United States). In Cuba it is a rather common tree and has an important phytocenological role in the first canopy layer of the swamp-forests and marsh-forests (*Chrysobalano-Annonetea*), in the semideciduous alluvial forests (*Ceibetea occidentalis*) and in the costal semideciduous forests (*Lysilomo-Burserion*). It is a very frequent tree in the swamp-region of the Zapata-Peninsule, in which it associates with *Bucida palustris* Borhidi et Muñiz, *Fraxinus caroliniana* Mill. ssp. *cubensis* (Griseb.) Borhidi, *Tabebuia angustata* Britt., *Metopium brownei* (Jacq.) Urb. and *Bursera simarouba* (L.) Sarg. forming the associations *Lysilomo-Metopietum brownei* Borhidi et Del-Risco, the *Lysilomo-Burseretum simaroubae* Borhidi et Del-Risco and taking part as a dominant species in the composition of other associations, e.g. *Hibisco-Calophylletum antillanae* Del-Risco. It is a very agressive invader species after the exploitation of the alluvial and swamp-forests. The wood of this species is widely used for charcoal-burning.

Myrsine cubana A. DC.

Shrubs or little trees up to 10 m height. Twigs and young branches glabrous. Leaves obovate or oblong, 3—10 cm long, 1.8—4 cm wide, rounded or obtuse at the apex and long attenuate at the base; blade shiny above, pale and dull beneath, lateral veins inconspicuous, glandular points hardly or not raised. Flowers in subsessile axillary fascicles, green, spotted by ferrugineous points, 4—5-merous. Sepals ovate, acute at the apex, 1.5 mm long. Corolla with obtuse lobes, ferrugineous puberulent at the margin. Stamens 5, filaments absent, anthers adnate to the corolla lobes. Ovary ovate, fruit globose, black when mature, about 5 mm in diameter.

Formerly this species was identified with *Rapanea guianensis* Aubl. or *Myrsine guianensis* (Aubl.) Kuntze, but Stearn (1969) proved this later species to live only in South America and did not occur in the Antilles, in which it is replaced by a number of different species of mostly restricted areas. One of these vicariant species of the guianensis-group is *Myrsine cubana* A. DC., endemic to Cuba (Borhidi, Imchanitskaya and Muñiz 1978).

It lives probably in all the provinces of Cuba, mostly in humid and inundated areas, in swamp-scrub forests, swamp- and alluvial forests, in which it grows as a rather common tree of the first or second canopy layer; sometimes it occurs also in the littoral marsh-forests as well, behind the mangrove-zone. It tolerates the long inundation, rather well even in brackish water.

Mastichodendron foetidissimum (Jacq.) Cronq.

Tree up to 25—30 m height. Bark separating into laminar plates, latex slightly orange, tastes bitter; twigs purplish, smooth, thin and glabrous. Leaves very diverse in size and shape, generally oblong, oblong-ovate, ovoide or sometimes elliptic to suborbicular, 5—15 cm long, mostly short-acuminate and obtuse or less frequently acute, rarely rounded at the apex, rounded or attenuate and obtuse at the base; blades shiny above, chartaceous, glabrous and characteristically undulate at the margin, petiole slender, 2—7 cm long. Flowers in few- or manyflowered axillary fascicles, which are shorter than the petioles. Pedicels 4—10 mm long, sepals 5, orbicular or suborbicular, obtuse, 2 mm long, glabrous; corolla greenish-yellow, 7 mm wides, lobes 5, oblong and obtuse; staminoids lanceolate, acuminate, 1 mm long. Ovary glabrous, ovules with basic-lateral placentation, mostly only 1 developing in each fruit. Berry drupaceous, ovoid, yellow, 2—2.5 cm long, glabrous, sour.

This species has an Antillean distribution pattern. It occurs in the West Indies except the Bahama Islands, but it can be found in Florida (United States) as well. In Cuba it is a very common tree species, growing in all the provinces of this country, and lives mostly in the lowland and submontane levels, up to 600—700 m a. s. l. It can be found in very different soils but more frequently in limestone areas and ranges. As for its phytocenological conditions, it plays an important role in the semideciduous forests and seasonal evergreen forests as a common member of the first canopy layer or sometimes as high emergent trees. Its wood is pale yellow, solid, heavy and resistant, used for balks, timbers and railway-sleepers.

Linociera bumelioides Griseb.

Shrub or tree up to 10—15 m height. Twigs glabrous; leaves elliptic, oblong-elliptic or sometimes obovate (ssp. obovalis Borhidi et Muñiz), 4—10 cm long, rounded to obtuse at the apex, long attenuate and cuneate at the base; blade glabrous, reticulate-veined on both surfaces, shiny above, subcoriaceous. Inflorescences axillary or terminal panicles, 2—3 cm long, puberulent; calyx 1.5—2 mm long, lobes ovate, acute, separated to the middle of the calyx; petals white, linear, 6—8 mm long. Stamens 2, filaments filiform, as long as the anthers. Ovary 2-locular, style short, stigma oblong, capitate; ovules 2 in each cavity. Fruit drupaceous, ovate, purplish, 11—12 mm in diameter; endocarp stone-hard.

This species has a Great-Antillean distribution pattern occurring in Cuba, Hispaniola and Andros Island, but fails in Jamaica and Porto Rico. It grows in the littoral limestone dogtooth areas on the nacked rocks or in very shallow rendzina- and protorendzina-soils, living in littoral semideciduous scrub-forests, dry evergreen littoral scrubs and thickets, associated with *Bombacopsis cubensis* A. Robyns, *Capparis cynophallophora* L., *Savia bahamensis* Britt., *Diospyros grisebachii* (Hiern.) Standl., etc. In the West Cuban dry littoral thickets, named *Linociero-Savietum bahamensis* Borhidi et Del Risco, plays an outstanding role as a dominant species of the association.

Wood anatomy

Curatella americana L.

Wood porous diffuse; the ground mass of the wood is formed by polygonal-shaped fibers with thick wall and narrow lumen and by wide medullary rays. Apotracheal and contact-vasicentric longitudinal parenchyma. Medullary rays with more cells in width (Fig. 1). Tracheae are round or flattened in radial direction, with medium sizes, and sometimes filled up by thyllis. Number is very few, 3 per 1 sq millimeter. Tangential diameter 86.7—165.6 μ. Radial diameter 34.5—133.4 μ. Vessel members are 426.0—923.0 μ long, with oblong bordered pits on the wall (Fig. 2). Perforation plate is simple.

Heterogeneous medullary rays with 4—12 cells in width. Height 230.0—10 350.0 μ. Width 23.0—414.0 μ. Cells of the medullary rays often contain bundle-shaped group of acicular crystals named "raphids" (Figs 3, 4).

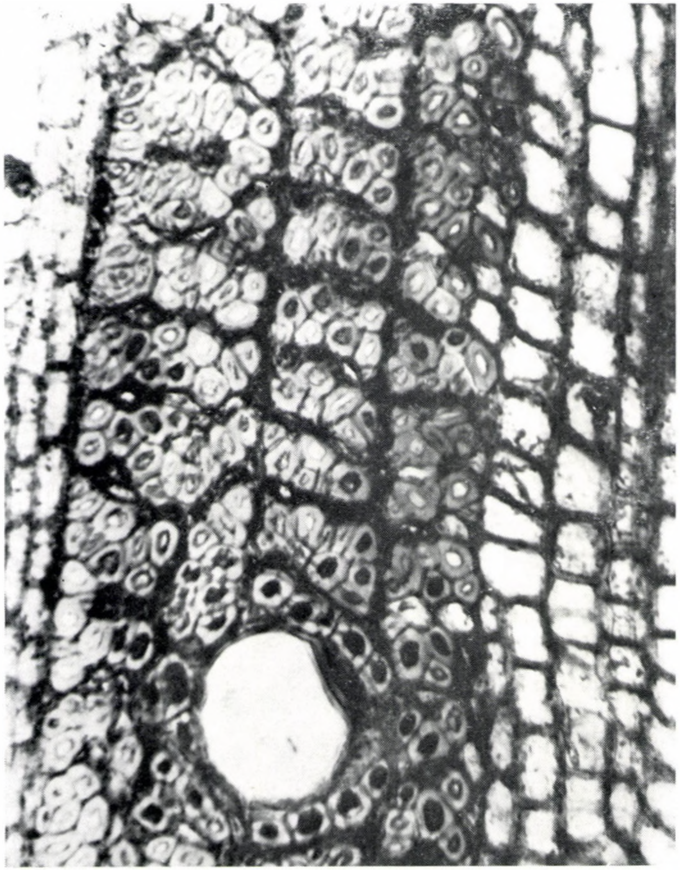

Fig. 1. Curatella americana L. Cross section ×120. Roundish solitary vessel. Wide medullary rays, apotracheal and contact parenchyma filled up with gum material. Wall of fibers thick, cavity filled up with gum material

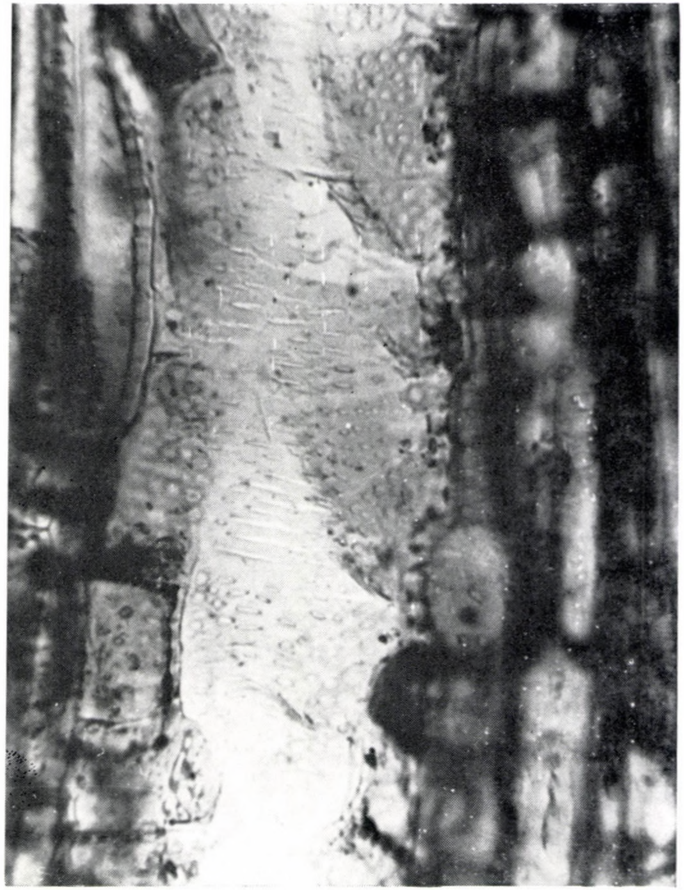

Fig. 2. Curatella americana L. Tangential section ×300. The oblong pits are distinctly visible on the wall of vessels

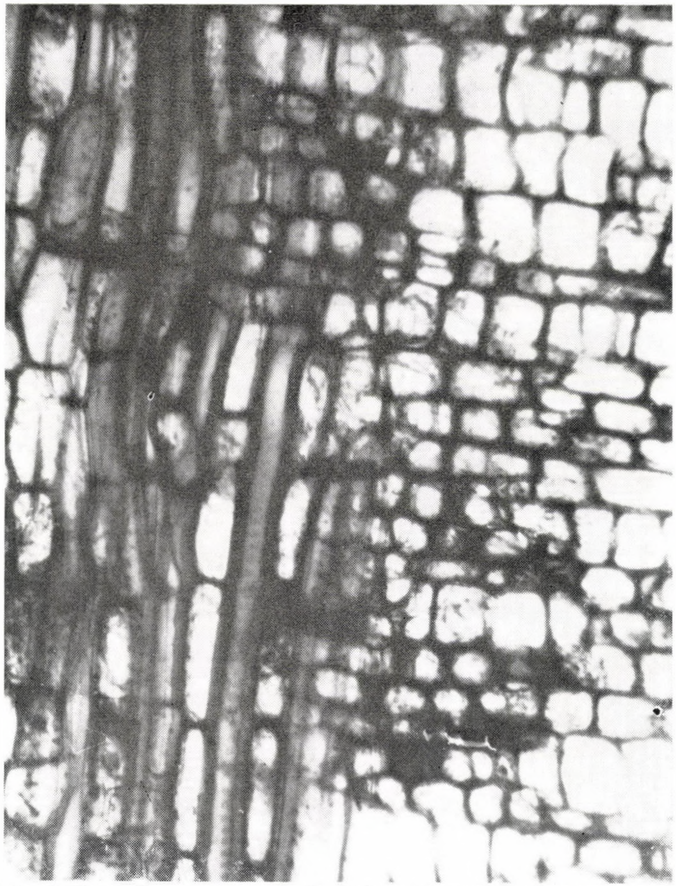

Fig. 3. Curatella americana L. Radial section ×120. Heterogeneous medullary rays. Longitudinal parenchyma and fibers

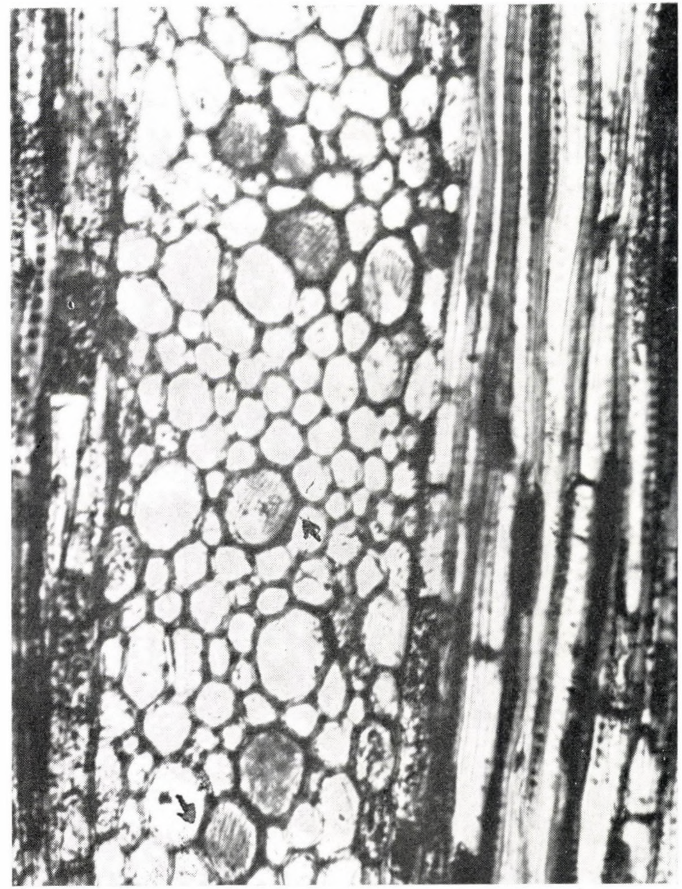

Fig. 4. Curatella americana L. Tangential section ×120. Wide medullary rays and fibers. Cells of medullary rays contain raphid crystals (→)

Fibers arranged in irregular lines. Diameter 25.3—48.3 μ. Wall thickness 3.4—12.6 μ. Full length 1065.0—2343.0 μ. Radial and tangential wall of fibers with bordered pits. Tips of the fibers commonly ending in a smooth peak, rarely toothed or forking. Diameter of the longitudinal parenchyma cells 9.3—37.2 μ. Height 55.8—181.3 μ. Cells rarely contain tetragonal bipyramidal crystals and often gum.

Luehea speciosa Willd.

Wood porous diffuse with annual ring structure. The ground mass of the wood is formed by fibers with thin wall and wide lumen. Apotracheal and contact-vasicentric longitudinal parenchyma. Medullary rays one or more cells in width (Fig. 5).

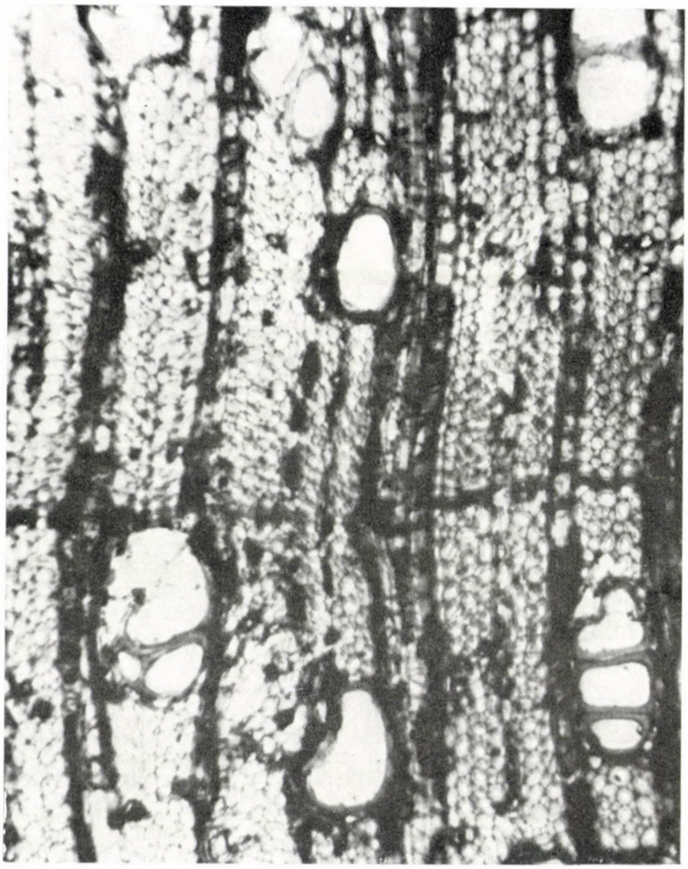

Fig. 5. Luehea speciosa Willd. Cross section ×120. Solitary vessels and groups of vessels. Medullary rays with 1 or more cells in width, filled up with mastic material. Scarce apotracheal and contact longitudinal parenchyma. Fibers with thin wall. The annual ring structure is distinctly visible

Fig. 6. Luehea speciosa Willd. Radial section ×120. Heterogeneous medullary rays, vessels and fibers. Cells of medullary rays contain mastic material. Marginal cells contain polygonal-shaped crystals

Fig. 7. Luehea speciosa Willd. Tangential section ×120. The very small pits are distinctly visible on the wall of vessels. Contact longitudinal parenchyma and fibers. Medullary rays with one or more cells in width

Solitary vessels are oval-shaped. Groups of vessels containing 2—4 members are flattened in radial direction. Number is 28 per 1 sq millimeter. Medium size. Tangential diameter 28.4—82.8 μ. Radial diameter 20.7—115.0 μ. Vessel members are 142.0—568.0 μ long, with small bordered pits on the wall. Simple perforation plate. Vessels sometimes filled up with gum material.

Medullary rays are 3—4 cells in width, with heterogeneous structure. Height 92.8—494.5 μ. Width 11.5—69.0 μ. Cells of the medullary rays contain gum material, marginal cells contain polygonal-shaped crystals (Figs 6 and 7).

Fibers in radial lines. Diameter 9.2—18.4 μ. Constant wall thickness 2.3 μ. Full length 710.0—1846.0 μ. Tips of the fibers longitudinally ending in a peak, rarely with saw-teeth, very rarely bifurcating.

Diameter of longitudinal parenchyma cells 9.3—23.2 μ. Height 41.8—106.95 μ. Cells contain gum material and polygonal-shaped crystals.

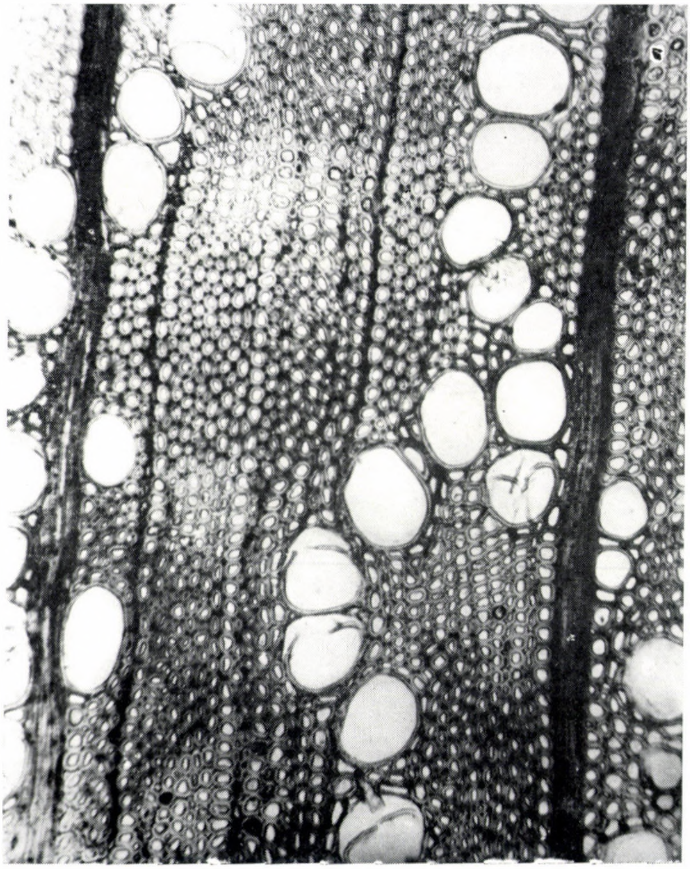

Fig. 8. Alvaradoa amorphoides Liebm. ssp. *psilophylla.* Cross section ×120. Roundish and oval-shaped groups of vessels. Fibers with medium wall thickness and a very scarce apotracheal longitudinal parenchyma. Medullary rays with one or more cells in width. Medullary rays contain mastic material

Alvaradoa amorphoides Liebm. ssp. *psilophylla* (Urb.) Cronq.

Wood porous diffuse. The ground mass of the wood is formed by fibers with medium wall thickness and vessels. Very scarce apotracheal longitudinal parenchyma. Medullary rays with one or more cells in width (Fig. 8). Solitary vessels are oval-shaped or slightly flattened in radial direction. The flame-shaped or obliquely settled vessel groups with more members are frequent. Number is 54 per 1 sq millimeter. Small size. Tangential diameter 20.7—69.0 μ. Radial diameter 23.0—62.0 μ. Length of vessel members 142.0—568.0 μ, with small oblong bordered pits on the wall. Simple perforation plate. They rarely contain gum material. Fiber tracheids with vasicentric position.

Medullary rays with 2—4, rarely 7 cells in width, with heterogeneous structure. 2—4 lines of marginal cells are characteristic. Height of medullary rays 69.0—675.0 μ. Width 11.5—68.6 μ. Cells of medullary rays contain gum material and polygonal-shaped crystals (Figs 9 and 10).

Fibers in radial lines or in irregular arrangement. Diameter 22.5—44.5 μ. Full length 852.0—2130.0 μ. Wall thickness 2.3—4.6 μ. Tips of fibers longitudinally ending in a peak or with saw-teeth, rarely bifurcating.

Cellular fibers form zones.

Diameter of longitudinal parenchyma cells 9.4—24.2 μ. Height 48.2—296.0 μ.

Cyrilla racemiflora L.

Wood porous diffuse, rarely with annual ring structure. The ground mass of the wood is formed by fibers with medium wall thickness. Apotracheal longitudinal parenchyma. Medullary rays with 1 or 2 cells in width (Fig. 11). Solitary vessels are round or oval-shaped. Vessel groups of 2—11 members in radial direction are frequent. Number is 46 per 1 sq millimeter. Small size. Tangential diameter 25.3—71.3 μ. Radial diameter 20.7—57.5 μ. Length of vessel members 213.0—639.0 μ, with bordered pits on the wall. Simple perforation plate.

Medullary rays one, rarely two cells in width, with heterogeneous structure. Marginal cells are often in 4 series (Figs 12, 13).

Fibers in irregular arrangement. Diameter 16.1—26.6 μ. Wall thickness 6.9—11.0 μ. Full length 710.0—1278.0 μ. Tips of fibers commonly ending in a smooth peak, sometimes with saw-teeth.

Diameter of longitudinal parenchyma cells 16.1—26.6 μ. Height 55.8—125.5 μ. Cells often contain gum material and cellular crystal holder longitudinal parenchyma.

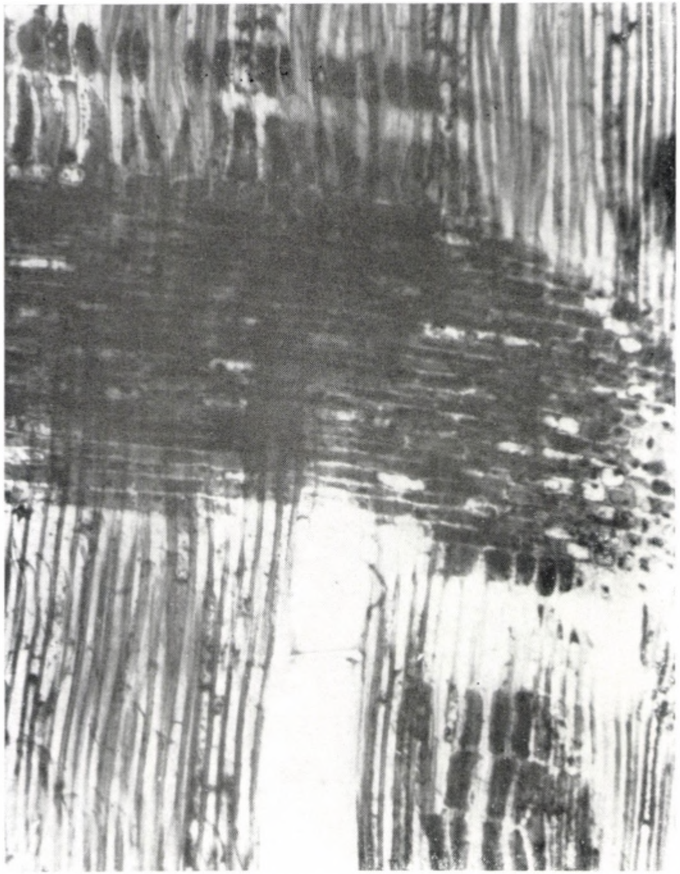

Fig. 9. Alvaradoa amorphoides Liebm. ssp. *psilophylla.* Radial section ×120. Heterogeneous medullary rays with marginal cell lines of 3 cells in width. Cells of medullary rays contain a large quantity of mastic material. Cells often contain polygonal-shaped crystals. Fibers and cellular fibers

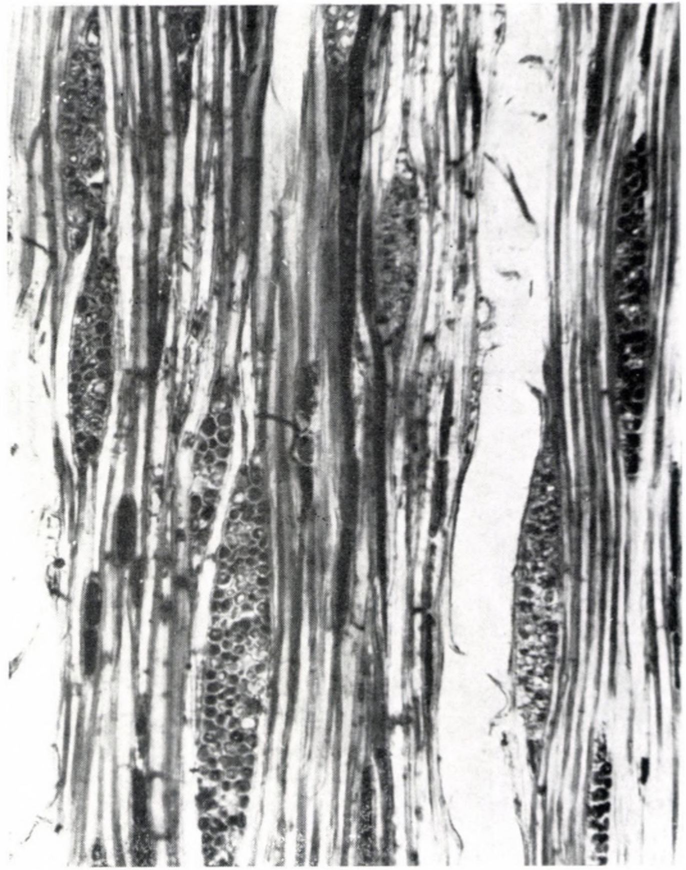

Fig. 10. Alvaradoa amorphoides Liebm. ssp. *psilophylla.* Tangential section ×120. Vessel, contact longitudinal parenchyma, heterogeneous medullary rays. Fibers and fiber tracheids

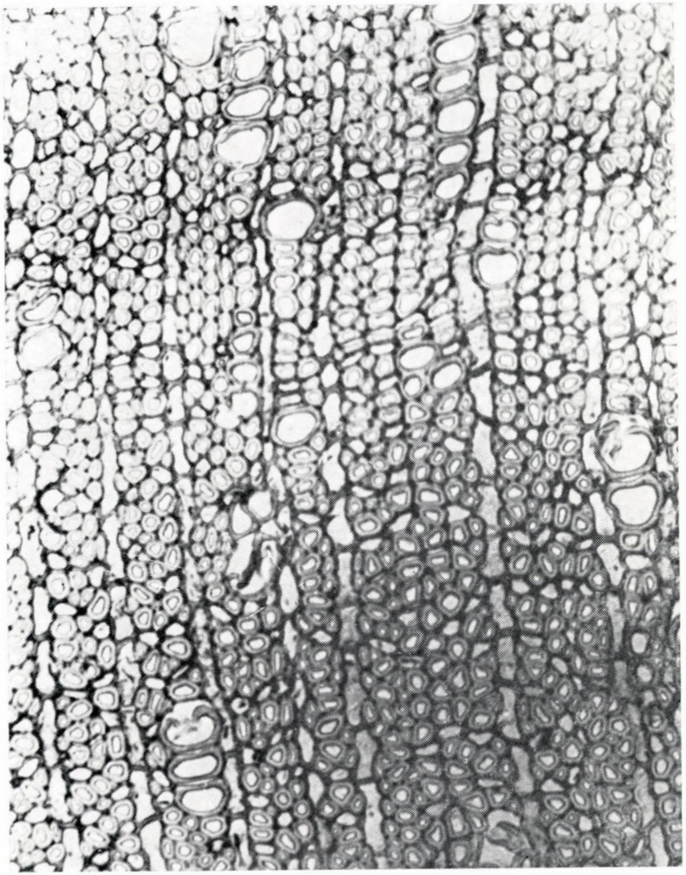

Fig. 11. Cyrilla racemiflora L. Cross section ×120. Vessels and groups of vessels and medullary rays with one cell in width. Wall of vessels relatively thick, small size. Medium thickness of fiber wall. Apotracheal longitudinal parenchyma

Fig. 12. Cyrilla racemiflora L. Radial section ×120. Heterogeneous medullary rays with marginal cell lines of 4 cells in width. Fibers, longitudinal parenchyma and cellular crystal holder longitudinal parenchyma (→)

Fig. 13. Cyrilla racemiflora L. Tangential section ×120. Heterogeneous medullary rays with one and two cells in width, vessel and fibers

Lysiloma bahamensis Benth.

Wood porous diffuse; the ground mass of the wood is formed by longitudinal parenchyma and fibers with thin wall. Abundant paratracheal and contact-vasicentric longitudinal parenchyma. Medullary rays uni- or triseriate (Fig. 14).

The solitary vessels with oval shape. Vessel groups of 2—4 members in radial direction are frequent. The vessels of the vessel groups are flattened in tangential direction. Number of vessels 7 per 1 sq mm. Medium size. Tangential diameter 41.1—184.0 μ. Radial diameter 20.7—181.7 μ. Length of vessel members 213.0—426.0 μ, with small alternative pits on the wall. Simple perforation plate.

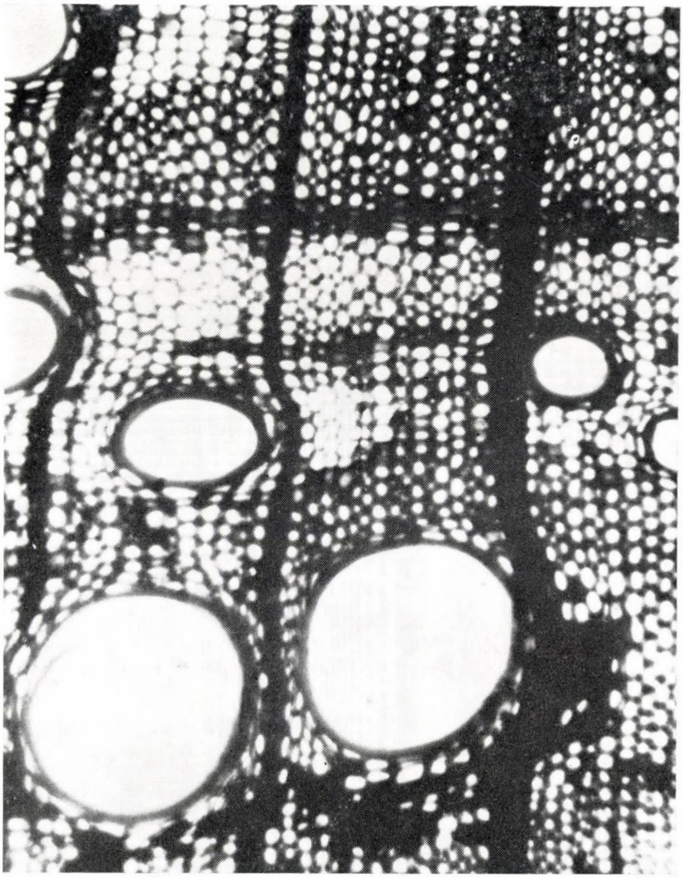

Fig. 14. Lysiloma bahamensis Benth. Cross section ×120. Solitary vessels and medullary rays with 1 and 3 cells in width. The wall of vessels is relatively thick, with medium sizes. Fibers with thin wall and large lumen. Paratracheal, contact-vasicentric longitudinal parenchyma

Medullary rays with one, two or three cells in width. Homogeneous structure. Height 69.0—345.0 μ. Width 11.5—34.5 μ. Cells are sometimes filled up by mastic material, rarely with crystals. Medullary rays within the wood almost scalariform (Figs 15, 16).

Fibers arranged in irregular lines. Diameter 11.5—20.7 μ. Wall thickness 6.9—9.2 μ. Full length 639.0—1207.0 μ. Tips of the fibers commonly ending in a smooth peak.

Diameter of longitudinal parenchyma cells 9.3—23.2 μ. Height 37.2—134.8 μ. Cells are often filled up with mastic. Cellular crystal holder longitudinal parenchyma is frequent.

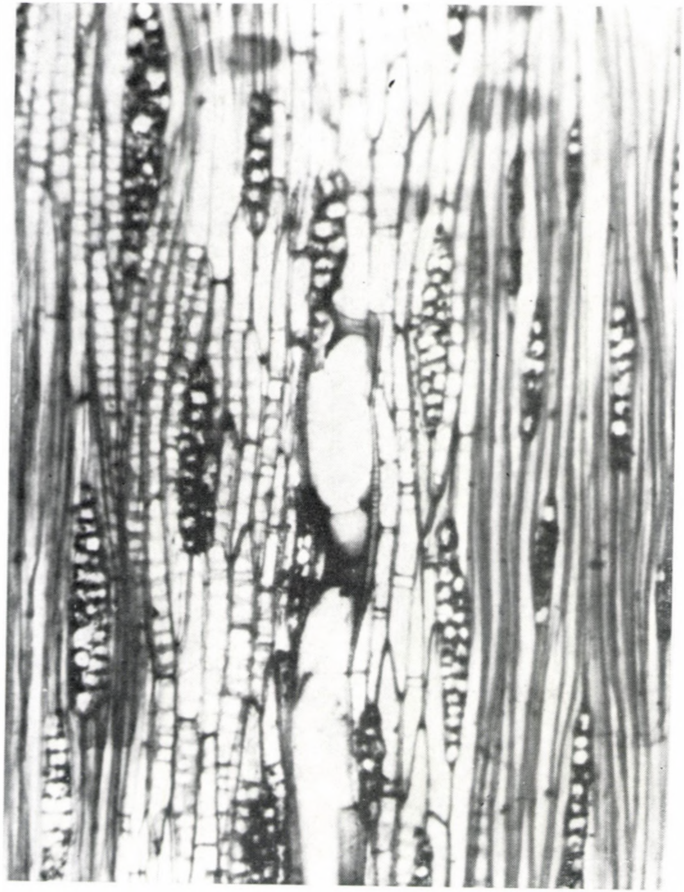

Fig. 15. Lysiloma bahamensis Benth. Radial section ×120. Homogeneous medullary rays, vessel and fibers

Fig. 16. Lysiloma bahamensis Benth. Tangential section ×120. Homogeneous medullary rays with 1—2—3 cells in width, vessel, with mastic material, fibers. Large quantity of crystal holder longitudinal parenchyma

Myrsine cubana A. DC.

Wood porous diffuse. The ground mass of the wood is formed by fibers with thick wall and narrow lumen. Scarce paratracheal and contact-vasicentric longitudinal parenchyma (WAGENFÜHR—SCHREIBER 1974, JANE 1950). Medullary rays are triseriate or sextain (Fig. 17).

The solitary vessels are polygonal-shaped. The vessel groups of 2—5 members in radial direction are frequent. Number of vessels 50 per 1 sq mm. Small sizes. Tangential diameter 27.6—69.0 μ. Radial diameter 41.4—73.6 μ. Length of vessel members 284.0—781.0 μ, with small, alternative pits on the wall. Simple perforation plate. Medullary rays with three or six cells in width.

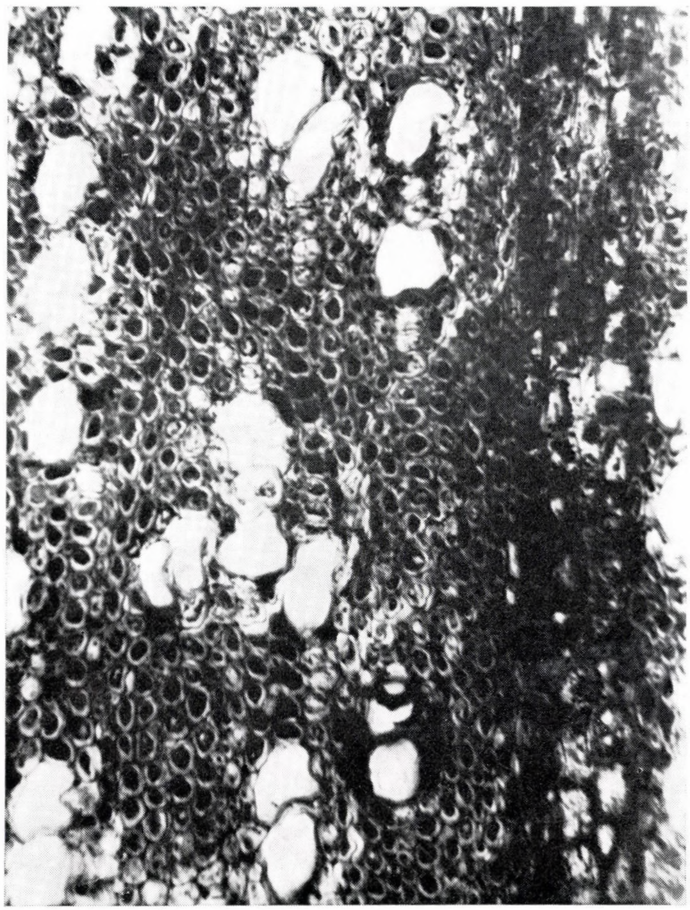

Fig. 17. Myrsine cubana A. DC. Cross section $\times 120$. Vessels and vessel groups; medullary ray with 6 cells in width. The wall of vessel is thin; small sizes. The wall of fibers is thick, the lumen contains mastic material. Scarce paratracheal and contact-vasicentric longitudinal parenchyma

Heterogeneous structure. Height 5750.0—7245.0 μ. Width 115.0—172.5 μ. 1—4 rows of marginal cells (standing cells). The marginal cells often change into idioblast and contain crystal sand. Medullary rays often filled up by mastic material (Figs 18, 19).

Fibers arranged in radial lines. Diameter 16.1—34.5 μ. Wall thickness 9.2—14.2 μ. Full length 639.0—1420.0 μ. Tips of the fibers end in a smooth peak.

Diameter of longitudinal parenchyma cells is 4.65—27.9 μ. Height 46.5—195.3 μ. Cells sometimes filled up by mastic.

Mastichodendron foetidissimum (Jacq.) Cronquist

Wood porous diffuse. Thenground mass of the wood is formed by fibers with thick wall and narrow lumen. Apotracheal longitudinal parenchyma.

Fig. 18. Myrsine cubana A. DC. Radial section ×120. Heterogeneous medullary rays with idioblast cell (→). Medullary rays contain mastic material and crystal. Vessels and fibers

Medullary rays uni- or biseriate (Fig. 20). Solitary vessels are oval-shaped. Groups of vessels containing 3—4 members are frequent. The vessels of the groups are flattened in tangential direction. Number of vessels 28 per 1 sq mm. Small size. Tangential diameter 18.4—82.8 μ. Radial diameter 34.5—82.8 μ. Length of vessel members 568.0—781.0 μ, with small, alternative pits on the wall. Simple perforation plate. Medullary rays with one or two cells in width. Heterogeneous structure. Height 172.5—483.0 μ. Width 11.5—23.0 μ. The uniseriate medullary rays commonly consist of procumbent cells. The biseriate medullary rays consist of 1—4 marginal cell rows (standing cells). Medullary rays rarely contain mastic material and calcium oxalate crystals (Figs 21, 22). Fibers are arranged in irregular lines. Diameter 13.8—23.0 μ. Wall thickness 11.5—20.7 μ. Full length 1065.0—2401.0 μ. Gelatinous and cellular fibers are scarce (METCALFE and CHALK 1950).

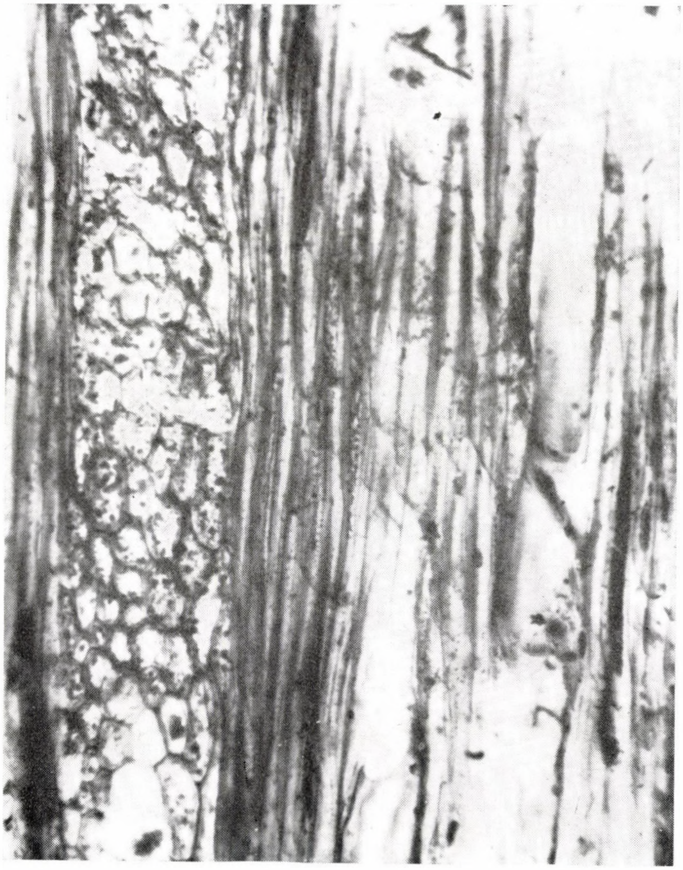

Fig. 19. Myrsine cubana A. DC. Tangential section ×120. Wide medullary ray with idioblast cells. Vessels and fibers. Besides the vessels contact-vasicentric longitudinal cells. The c els contain mastic material

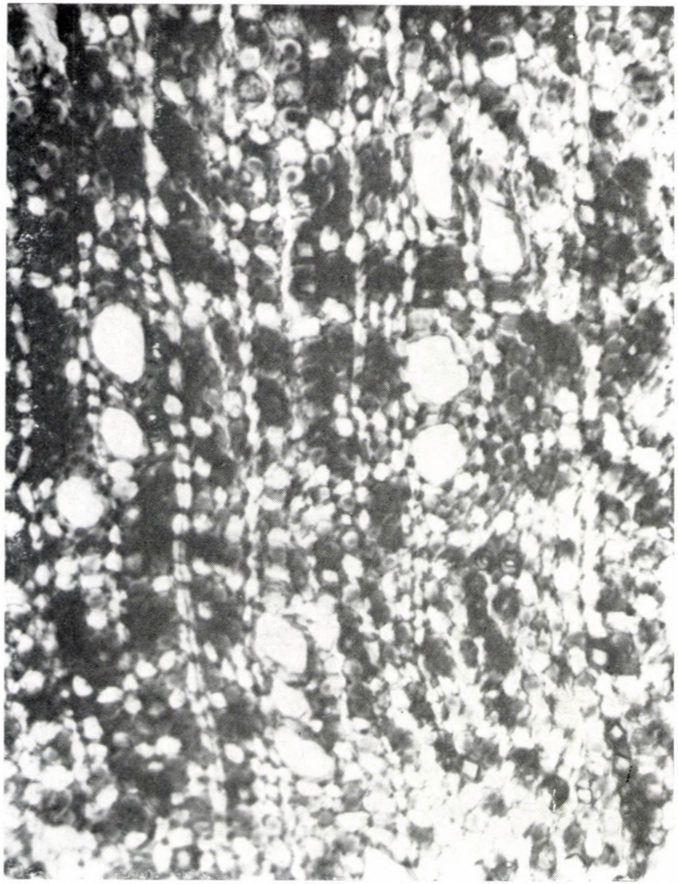

Fig. 20. Mastichodendron foetidissimum (Jacq.) Cronquist. Cross section ×120. Vessels and medullary rays with 1 and 2 cells in width. Vessels with thin wall and small sizes. The wall of fibers is thick, the lumen is narrow, with mastic material. Large quantity of apotracheal longitudinal parenchyma

Fig. 21. Mastichodendron foetidissimum (Jacq.) Cronquist. Radial section ×120. Heterogeneous medullary rays. Vessel, fibers, and longitudinal parenchyma

Tips of the fibers end in smooth peak or bifurcate, with toothed margin.

Diameter of longitudinal parenchyma cells 9.3—13.8 μ. Height 32.5—106.9 μ. The longitudinal crystal holder parenchyma is frequent.

Linociera bumelioides Griseb.

Wood porous diffuse. The ground mass of the wood is formed by fibers with thinner wall and narrower lumen. Terminal and contact-vasicentric, scarce apotracheal longitudinal parenchyma. Medullary rays uni- or biseriate (Fig. 23).

Solitary vessels are oval-shaped. Groups of vessels containing 2—6 members in radial direction are frequent. The vessels of the groups are flattened in tangential direction. Number of vessels 50 per 1 sq millimeter. Small sizes. Tangential diameter 20.7—59.8 μ. Radial diameter 20.7—73.6 μ. Length of

Fig. 22. Mastichodendron foetidissimum (Jacq.) Cronquist. Tangential section ×120. Medullary rays with 1 or 2 cells in width, fibers and longitudinal parenchyma

vessel members 284.0—639.0 μ, with small pits on the wall. Simple perforation plate. Vessels often contain tyloses and mastic material.

Medullary rays with one or two cells in width; heterogeneous structure. Height 69.0—644.0 μ. Width 11.5—34.5 μ. Marginal cells form 1—4 rows (standing cells). Medullary rays cells contain a large quantity of crystals and crystal sand (Figs 24, 25).

Fibers are arranged in radial lines. Diameter 6.9—18.4 μ. Wall thickness 4,6—13.8 μ. Full length 710.0—1420.0 μ. Tips of fibers lengthwise end in a smooth peak, rarely toothed and forking.

Diameter of longitudinal parenchyma cells 9.3—23.2 μ. Height 69.7—153.4 μ. Cells rarely contain crystals.

Detailed anatomical features of the species are shown in Tables, 1, 2, 3, and 4.

Fig. 23. Linociera bumelioides Griseb. Cross section $\times 120$. Vessels and vessel groups, fiber with moderately thick wall and medullary rays with 1 cell in width. The wall of vessels is thick, lumen with mastic material. Contact-vasicentric longitudinal parenchyma in terminal positio:n

Fig. 24. Linociera bumelioides Griseb. Radial section ×120. Heterogeneous medullary rays, vessels with mastic material, fibers. Around the vessels contact-vasicentric longitudinal parenchyma cells

Fig. 25. Linociera bumelioides Griseb. Tangential section ×120. Medullary rays with 1 and 2 cells in width. Vessels, longitudinal parenchyma and fibers

Table 1

Detailed anatomical features of the species

Elements	Features	*Curatella americana*	*Luehea speciosa*
Trachea members	Arrangement	diffuse, solitary	diffuse, solitary or radial groups of 2—4 members
	Shape	roundish or flattened in radial direction	oval
	Tangential diameter	86.7—165.6 μ	28.4— 82.8 μ
	Radial diameter	34.5—133.4 μ	20.7—115.0 μ
	Length of vessel members	426.0—852.0 μ	142.0—568.0 μ
	Number per sq mm	3	28
	Wall thickness	2.3—11.5 μ	2.3—9.2 μ
	Intervascular pitting	oblong pit	pit
	Perforation plate	simple	simple
	Content	tyloses	gum
Medullary	Width	multiseriate	uni- to twoseriate
	Number of cells	4—12	1—4
	Classification	heterogeneous	heterogeneous
	Height	230.0—10 350.0 μ	92.8—494.5 μ
	Width	23.0—414.0 μ	11.5— 69.0 μ
	Content	acicular crystals-raphids	crystal, gum
Fibers	Arrangement	irregular	in radial lines
	Shape	polygonal	polygonal
	Full diameter	25.3—48.3 μ	9.2—18.4 μ
	Wall thickness	3.4—12.6 μ	2.3 μ
	Full length	1065.0—2343.0 μ	710.0—1846.0 μ
	Type of pitting	bordered	simple
Longitudinal parenchyma	Arrangement	apotracheal and contact vasicentric	apotracheal and contact vasicentric
	Diameter	9.3— 37.2 μ	9.3— 23.2 μ
	Height	55.8—181.3 μ	41.8—106.9 μ
	Number of cells	1	1—2
	Content	gum	mastic
	Other	crystal	crystal

Table 2

Detailed anatomical features of the species

Elements	Faetures	*Alvaradoa amorphoides* ssp. *psilophylla*	*Cyrilla racemiflora*
Trachea members	Arrangement	diffuse, grouped	diffuse or in radial direction group of 2—11 members
	Shape	oval	roundish or oval
	Tangential diameter	20.7— 69.0 μ	25.3— 71.3 μ
	Radial diameter	23.0— 62.0 μ	20.7— 57.5 μ
	Length of vessel members	142.0—568.0 μ	213.0—639.0 μ
	Number per sq mm	54	46
	Wall thickness	2.3 μ	2.3—6.9 μ
	Intervascular pitting	oblong pit	pit
	Perforation plate	simple	simple
	Contain	rarely mastic	—
Medullary rays	Width	uni- to multiseriate	uni- to twoseriate
	Number of cells	1—4—7	1—2
	Classification	heterogeneous	heterogeneous
	Height	69.0—675.0 μ	69.0—632.5 μ
	Width	11.5— 68.6 μ	11.5— 23.0 μ
	Content	mastic	—
Fibers	Arrangement	in radial lines or irregular	irregular
	Shape	polygonal	polygonal
	Full diameter	22.5— 44.5 μ	16.1— 26.6 μ
	Wall thickness	2.3— 4.6 μ	6.9— 11.0 μ
	Full length	825.0—2330.0 μ	710.0—1278.0 μ
	Type of pitting	simple	bordered
Longitudinal parenchyma	Arrangement	scarce apotracheal	apotracheal
	Diameter	9.4— 24.2 μ	16.1— 26.6 μ
	Height	48.2—296.0 μ	55.8—125.5 μ
	Number of cells	1	1
	Content	—	mastic
	Other	—	crystal holder longitudinal parenchyma

Table 3

Detailed anatomical features of the species

Elements	Features	*Lysiloma bahamensis*	*Myrsine cubana*
Trachea members	Arrangement	diffuse, solitary or radial lines of 2—4 members	diffuse, rarely solitary, radial lines of 2—5 members
	Shape	oval or flattened in tangential direction	oval
	Tangential diameter	41.4—184.0 μ	27.6— 69.0 μ
	Radial diameter	20.7—181.7 μ	41.4— 73.6 μ
	Length of vessel members	213.0—426.0 μ	284.0—781.0 μ
	Number per sq mm	7	49
	Wall thickness	4.6—13.8 μ	2.3 μ
	Intervascular pitting	pit	pit
	Perforation plate	simple	simple
	Content	mastic	mastic
Medullary rays	Width	uni- or multiseriate	multiseriate
	Number of cells	1—2—3	3—6
	Classification	homogeneous	heterogeneous
	Height	69.0—345.0 μ	5750.0—7245.0 μ
	Width	11.5— 34.5 μ	115.0— 172.5 μ
	Content	mastic, rarely crystals	mastic, idioblast with crystal sand
Fibers	Arrangement	irregular	in radial lines
	Shape	polygonal	polygonal
	Full diameter	11.5—20.7 μ	16.1— 34.5 μ
	Wall thickness	6.9—9.2 μ	9.2— 14.2 μ
	Full length	639.0—1207.0 μ	639.0—1420.0 μ
	Type of pitting	simple	bordered
Longitudinal parenchyma	Arrangement	paratracheal, contact-vasicentric	scarce paratracheal contact-vasicentric
	Diameter	9.3— 23.2 μ	4.65— 27.9 μ
	Height	37.2—134.8 μ	46.5 —195.3 μ
	Number of cells	2—3	1
	Content	mastic	mastic
	Other	crystal holder longitudinal parenchyma	—

Table 4

Detailed anatomical features of the species

Elements	Features	*Mastichodendron foetidissimum*	*Linociera bumelioides*
Trachea members	Arrangement	diffuse, solitary or radial lines of 3—4 members	diffuse, solitary or radial lines of 2—6 members
	Shape	oval or flattened in tangential direction	oval or flattened in tangential direction
	Tangential diameter	18.4— 82.8 μ	20.7— 59.8 μ
	Radial diameter	34.5— 82.8 μ	20.7— 73.6 μ
	Length of vessel members	568.0—781.0 μ	284.0—639.0 μ
	Number per sq mm	28	50
	Wall thickness	2.3—6,9 μ	2.3—6.9 μ
	Intervascular pitting	pit	pit
	Perforation plate	simple	simple
	Contain	—	mastic and tyloses
Medullary rays	Width	uni- or biseriate	uni- or biseriate
	Number of cells	1—2	1—2
	Classification	heterogeneous	heterogeneous
	Height	172.5—483.0 μ	69.0—644.0 μ
	Width	11.5— 23.0 μ	11.5— 34.5 μ
	Content	mastic, crystals	crystal and crystal sand
Fibers	Arrangement	irregular	in radial lines
	Shape	polygonal	polygonal
	Full diameter	13.8— 23.0 μ	6.9— 18.4 μ
	Wall thickness	11.5— 20.7 μ	4.6— 13.8 μ
	Full length	1065.0—2401.0 μ	710.0—1420.0 μ
	Type of pitting	bordered	bordered
Longitudinal parenchyma	Arrangement	apotracheal	terminal and contact-vasicentric, scarce apotracheal
	Diameter	9.3— 13.8 μ	9.3— 23.2 μ
	Height	32.5—106.9 μ	69.7—153.4 μ
	Number of cells	1, rarely 2	1
	Content	crystal sand, crystal	crystal
	Other	crystal holder longitudinal parenchyma	—

Origin of the samples

Curatella americana L.: Cuba; Prov. Pinar del Rio; Sierra de los Organos near Minas de Matahambre, in altit. of approx. 200 m. Collected by M. VALES and A. BORHIDI, 25. 11. 1974. No.: 56.

Luehea speciosa Willd.: Cuba; Prov. Pinar del Rio; Sierra del Rosario, Loma el Salón near Cayajabos, in altit. approx. 350 m. Collected by M. VALES, 20. 11. 1974. No.: 47

Alvaradoa amorphoides Liebm. ssp. *psilophylla* (Urb.) Cronq.: Cuba; Prov. Pinar del Rio; Peninsule of Guanahacabibes: El Veral Nature Conserv. Area, in altit. approx. 10—20 m. Collected by M. VALES and A. BORHIDI, 14. 12. 1974. No.: 91

Cyrilla racemiflora L.: Cuba; Prov. Pinar del Rio; Sierra de Cajalbana, Loma Preluda in altit. approx. 150 m. Collected by M. VALES and A. BORHIDI, 27. 11. 1974. No.: 70

Lysiloma bahamensis Benth.: Cuba; Prov. Matanzas; Peninsule of Zapata near to Playa Larga. Collected by M. VALES, 8. 4. 1974. No.: 122

Myrsine cubana A. DC.: Cuba; Prov. Pinar del Rio; Peninsule of Guanahacabibes: El Veral Nature Conserv. Area, in altit. approx. 5—10 m. Collected by M. VALES and A. BORHIDI, 14. 12. 1974. No.: 104

Mastichodendron foetidissimum (Jacq.) Cronq.: Cuba; Prov. Camagüey; Sieara de Cubitas, Cerro Tuabaquey, in alt. approx. 300m. Collected by M. VALES 8. 5. 1975. No.:127.

Linociera bumelioides Griseb.: Cuba; Prov. Pinar del Rio; Peninsule of Guanahacabibes: El Veral Nature Conserv. Area in altit. approx. 10—20 m. Collected by M. VALES and A. BORHIDI, 12. 12. 1974. No.:78.

The samples are registered in the wood collection of the Botanical Institute of the Academy of Sciences of Cuba; Havanna.

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AN ELECTRONMICROSCOPICAL STUDY OF CHLAMYDOMONAS MEDIA KLEBS (CHLOROPHYTA) IN WET STATE

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The recently developed electronmicroscopical technique allows the study of biological specimen in nearly natural environments. The possible morphological changes in the specimen caused by radiation was investigated. In the case of the *Chlamydomonas media* no obvious morphological changes could be observed during the experiment.

Introduction

The endeavour to study the biological materials in the wet state so as not to destroy the structure by drying is almost as old as the science of electron microscopy itself. A lot of efforts have been made to overcome difficulties involved in carrying out experiments in high vacuum. Static [MARTON (1935), DUPOUY et al. (1960) — HVEM, STOYANOVA et al. (1959), HEIDE (1962), DUPOUY et al. (1962) — HVEM, ESCAIG et al. (1966), SWIFT et al. (1970) — STEM, FUKAMI et al. (1970), ALLINSON et al. (1972) — HVEM, MORGAN et al. (1973) — STEM] and dynamic [RUSKA (1942), ITO et al. (1958), SWANN et al. (1971)— HVEM, double-stage, WARD et al. (1972) — HVEM, MATRICARDI et al. (1972) — double-stage, TIGHE et al. (1973) — HVEM, PARSONS et al. (1975) — STEM, double-stage] chambers — with specimen space connected or separated — have been developed (see Fig. 1). (HVEM — high voltage electron microscope; STEM — scanning transmission electron microscope.) The problems posed by these chambers were discussed by KÁLMÁN et al. (1975, 1976).

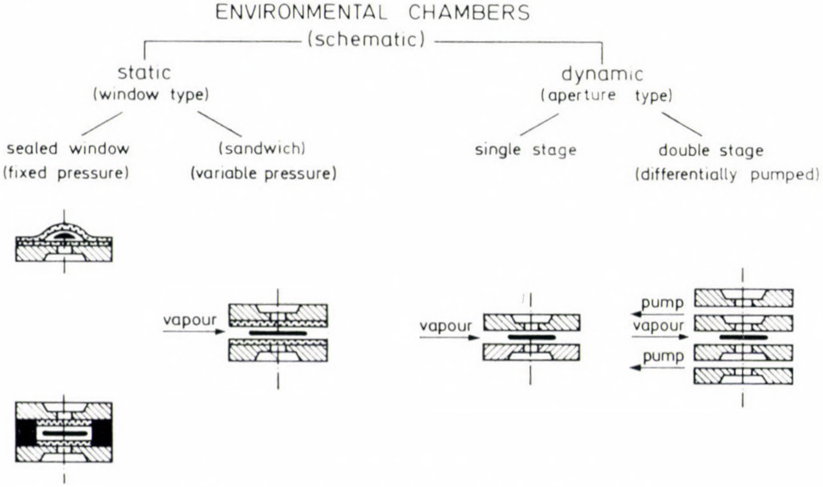


Fig. 1. Environmental chambers (schematic)

Experimental

The microchamber developed (KÁLMÁN et al. 1976), [see Figs. 2 and 3; exit and entrance aperture and specimen layer (1), tube introducting wet-sample (2), sample-feeding (2*); sample-reservoir, 1 cm^3 injection-syringes (2**)] allows electronmicroscopical investigation of the specimens in the wet state which was the first presentation of this phenomenon verified by specimen movement. The chamber is attached to the Zeiss EF 4 electron-optical device [see Fig. 3: electron-optical column (5)]. The pressure in the chamber approaches equilibrium and is maintained by water vapour coming from a buffer system (3). A thin specimen layer is continually formed in the chamber [Fig. 3: (2), (2*), (2**), (4)].

Further problems in the electronmicroscopic study of biological materials are due to radiation damage (GLAESER 1975). The question may arise whether radiation causes any morphological changes in the specimen under the experimental conditions in the microchamber: the specimen in the wet thin layer surrounded by water vapour is in motion; the beam current ranges between 10^{-3} and 10^{-2} A cm^{-2}; accelerating voltage: $\sim$67 kV; very short exposure time; temperature below 10 °C with continuous feed of fresh specimen.

As it was to carry out the experiments at lower equilibrium vapour pressure [liquid nitrogen cooled trap Fig. 4 (7) mounted around the chamber prevents vapour from entering electron-optical column], below 10 °C, a biological specimen moving at low temperatures and sensitive to harmful outside effects was required.

The electronmicroscopical picture appearing on the screen [ZnS, Fig. 4 (9)], was taken by the cine-camera [Fig. 4 (6)] with the window [Pb-Glass Fig. 4 (8)] of the electron-optical column in between. The camera type: Cameflex 35 mm, mounted outside the electron-optical device. Recording of the moving specimen in the electron microscope was difficult, the conventional photoplate-technique [Fig. 4 (10)] was too slow as the necessary exposure time of the moving pictures ranged between 1/30 to 1/250 sec and did not give quite satisfactory results. In order to improve the quality of the electronmicroscopical picture we must further develop our recording system (e.g. by use of an image intensifier, fibre optics and video recorder).

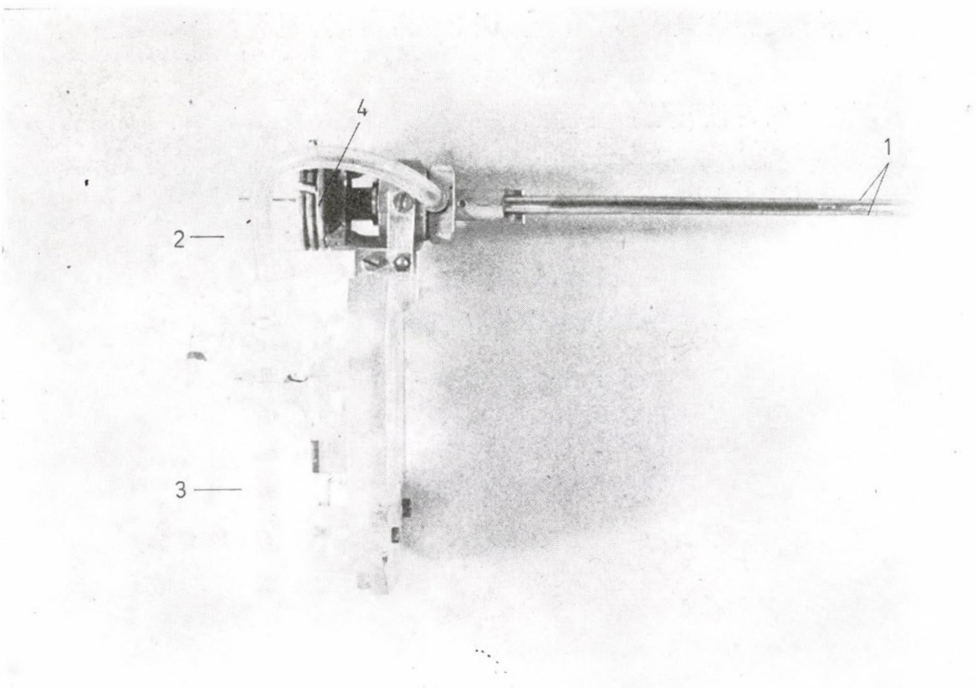


Fig. 2. The microchamber developed by KÁLMÁN et al.

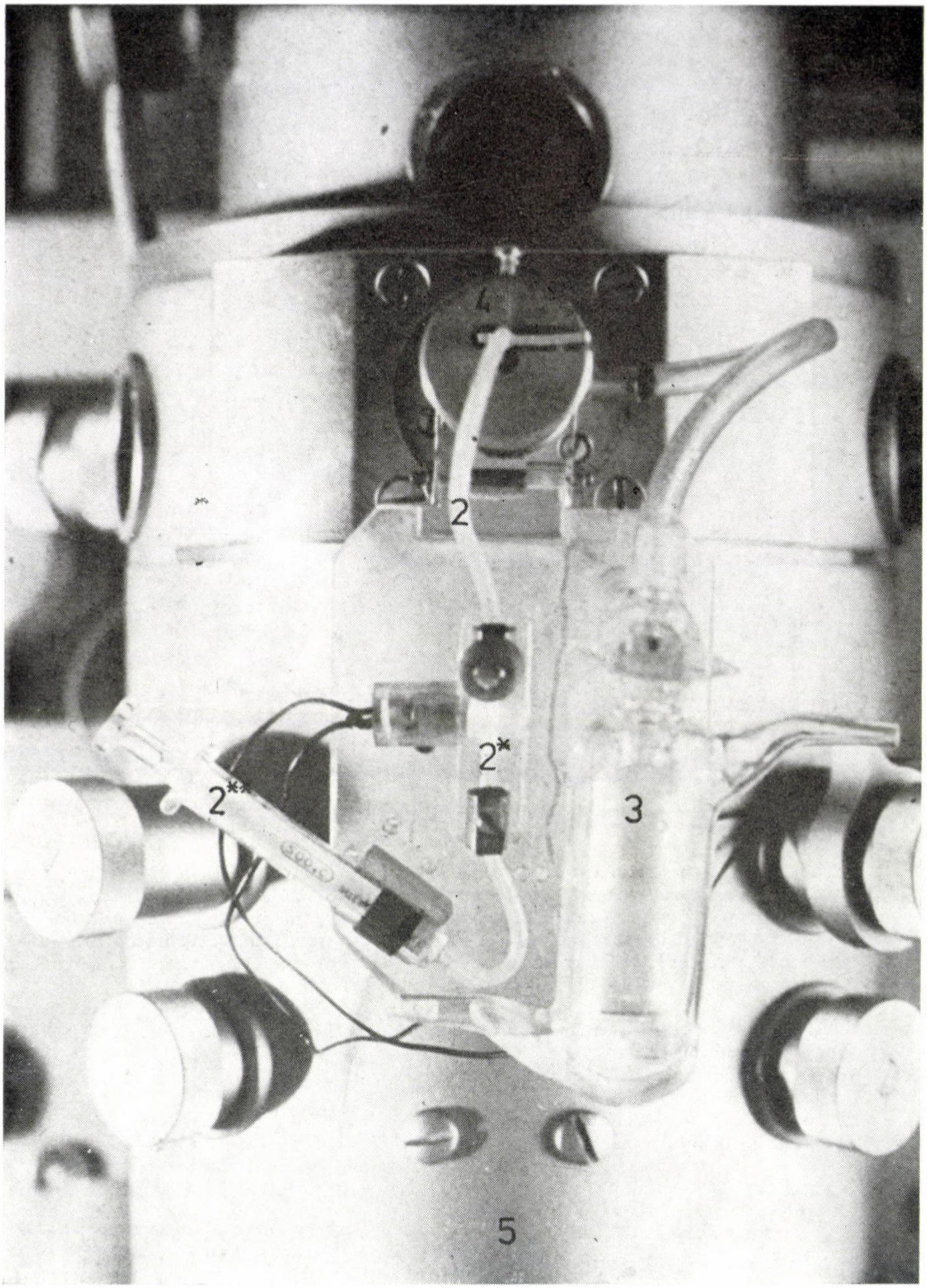


Fig 3. The microchamber attached to the electron microscope.

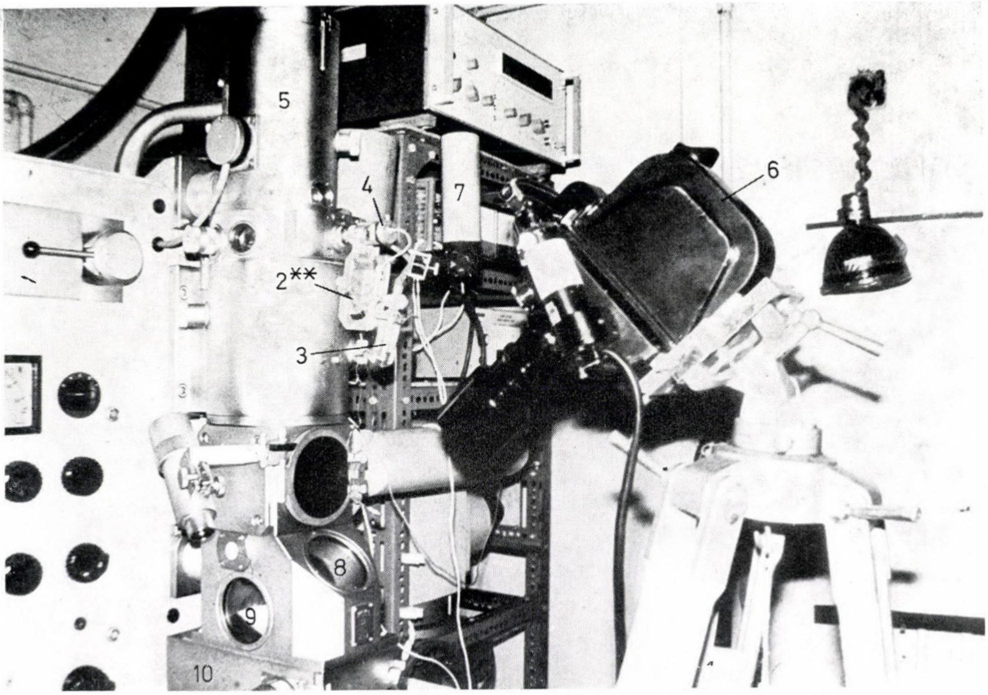


Fig. 4. The main part of the electron microscope

Material

On the basis of theoretical and practical considerations [ARTARI (1913, 1914), KATER (1929), LUCKSCH (1932), KUWADA (1932)] some members of the genus *Chlamydomonas* seem to be good for electronmicroscopical examinations. These organisms are relatively small, with active motion and well visible organella [e.g. flagella, eye-spot, pyrenoid, chloroplast (Plate 1, Fig. 5)]. On the other hand, in early spring the soil inhabiting *Chlamydomonas* species is able to form numerous swarmers (zoospores) in relatively short time.

The cell mass of *Chlamydomonas media* Klebs — applied as object of examinations — was obtained from forest soil and its cultures can be found in the Bot. Dept. Hung. Natural History Museum, Budapest.

The unialgal cultures of *Chlamydomonas media* were kept in Bold liquid medium STEIN (1973).

The individuals of *Chlamydomonas media* are ovoid in form. The two equal flagella always arise anteriorly, through a papilla-like thickening of the membrane. The eye-spot is located at the side of the chloroplast. The latter is basin-shaped with a lateral pyrenoid. The form and location of cell-organella are variable. In the material examined there were gametozoospores and vegetative cells as well.

The gametozoospores of *Chlamydomonas media* are 11—13 μm long and 5—5.5 μm wide. The vegetative cells are 18—20 μm long and 9—11 μm wide (Figs. 5—8).

The mass of *Chlamydomonas media* cells was transferred into fresh Bold liquid media in the Centr. Res. Inst. Chem. Hung. Acad. Sci. Budapest, because the cells loose their flagella already during a very careful transport.

After 24 hours the culture-medium was coloured by numerous moving cells. A small area of culture-vessel was illuminated with cool light. The zoospores were accumulated at this place by their fotoactivity, so the cell-concentration was the best for the electronmicroscopical examination.

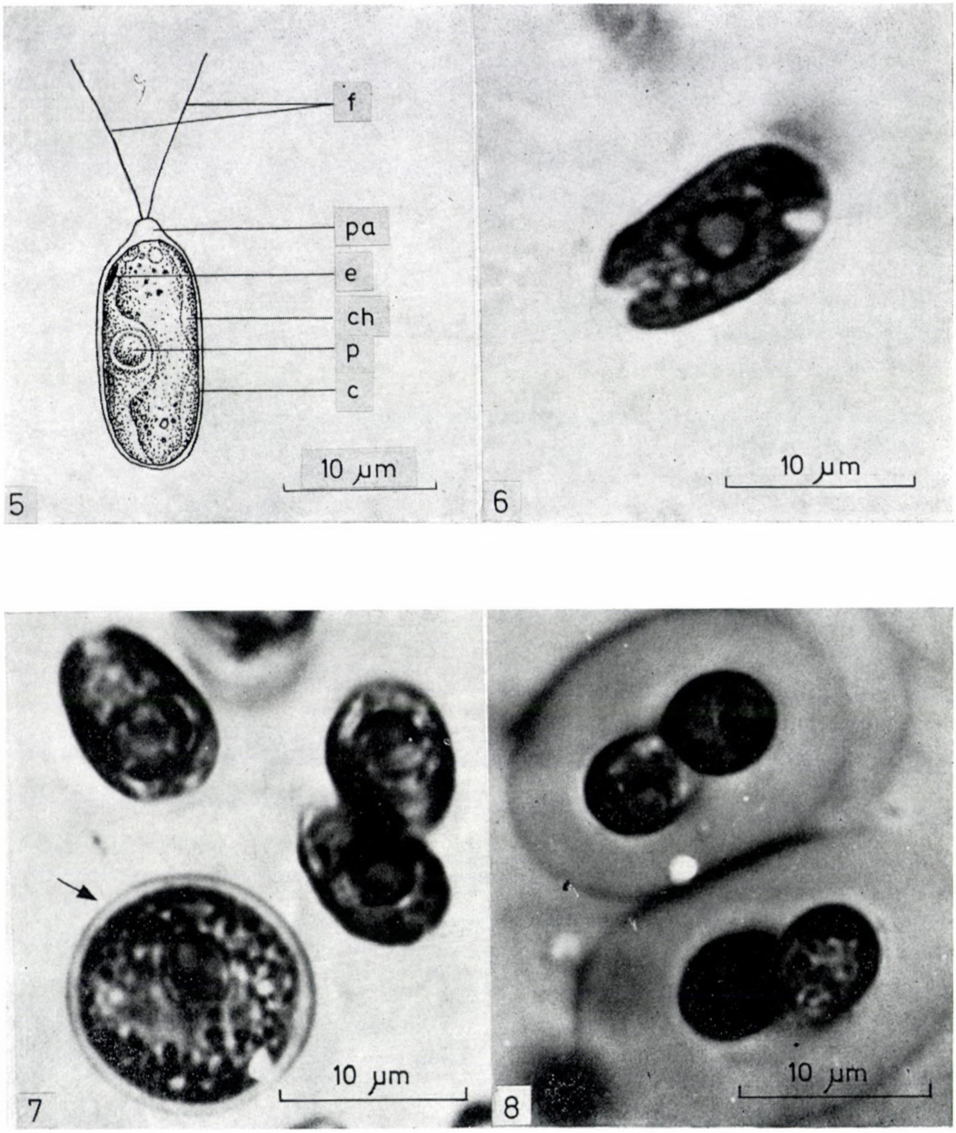
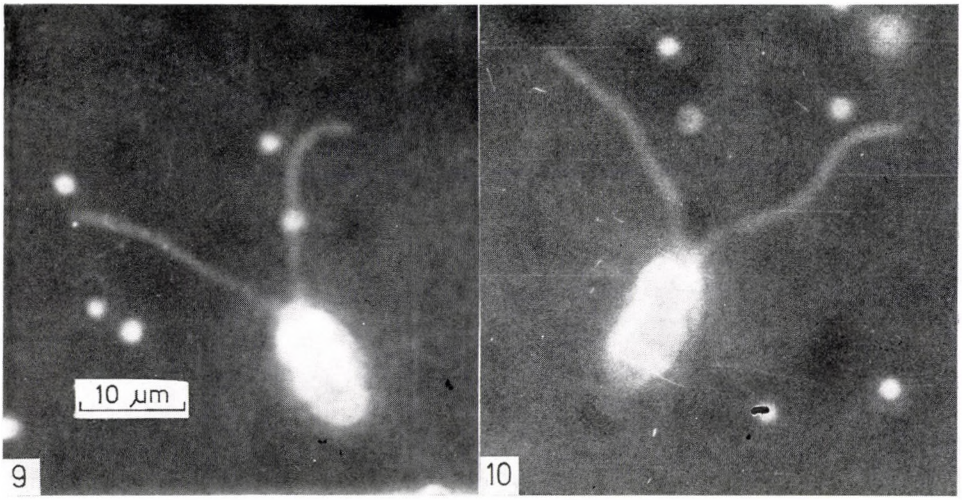


Fig. 5. The structure of the vegetative cell of *Chlamydomonas media:* f — flagella; pa — papilla; e — eyespot; c — cell wall; ch — chloroplast; p — pyrenoid
Fig. 6. A vegetative cell of *Chlamydomonas media;* it was dyed by janus-green
Figs 7—8. *Chlamydomonas media* cells in different stages of life cycle (KOMÁROMY 1976) 7 — resting stage; 8 — vegetative reproduction formation of zoospores

Results

The sensitivity of the *Chlamydomonas media* cells was tested. Due to mechanical or chemical effects (e.g. shaking, colouring matters, glycerol, distilled water) the moving cells draw in or come off their flagella. These procedures



Figs 9—10. Chlamydomonas media specimen in dark field, lightmicroscope 9—10 — living zoospores, the flagella are in different position of the move

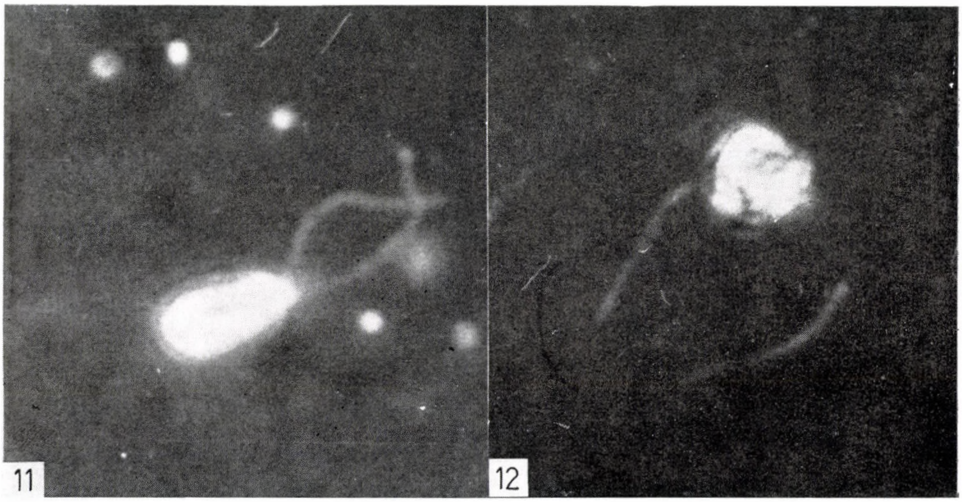
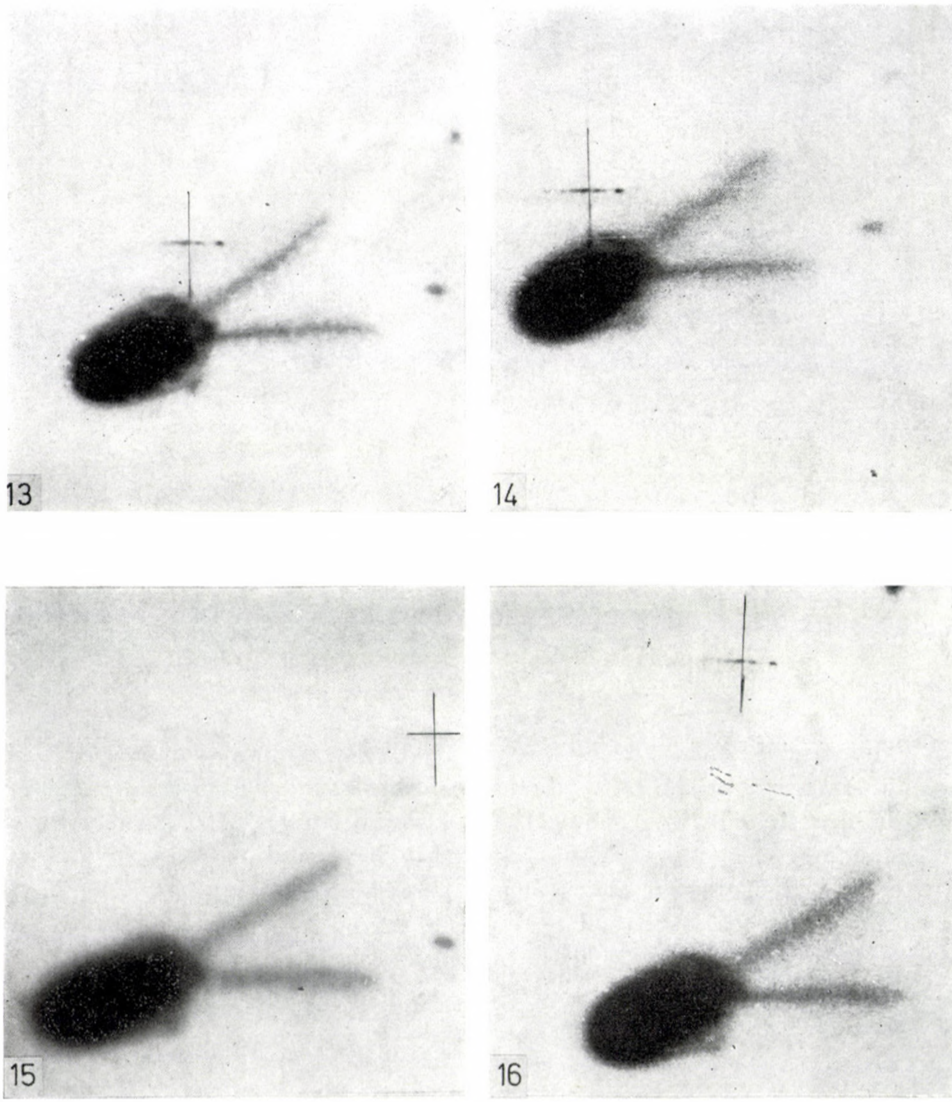


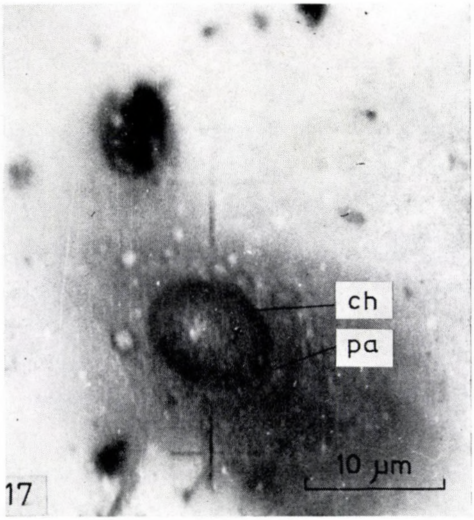
Fig. 11. Flagella sticked
Fig. 12. The cell lost their flagella by the effect of glycerole

were examined and photographed under traditional light microscope. Figs 9, 10 and 11 show a *Chlamydomonas* cell moving about in the media (light-microscopical picture, dark field). After introduction of glycerol, however, the cell ceased to move and lost its flagella (see Fig. 12).



Figs 13—16. The electronmicroscopical pictures of *Chlamydomonas media* specimen

The electronmicroscopical pictures are shown in Figs 13—17. The interval between consecutive exposures is 1/50 sec. The screen centre is marked by a cross. The displacement is caused by the shift of the specimen layer. The active movement is hindered by the streching out of the flagella in the thin (1000 Å) liquid layer. No obvious structural changes occur during the examination (with the exception of the possible contraction visible on Fig. 13).



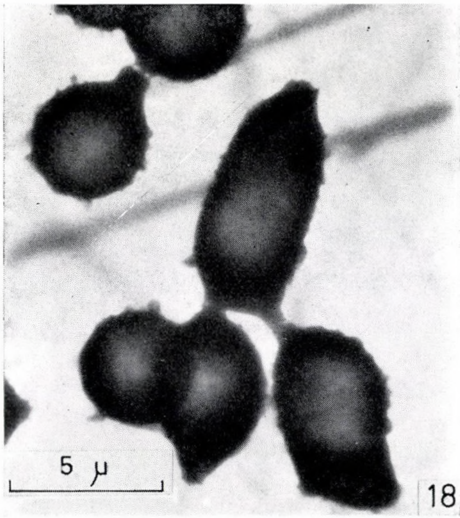


Fig. 17. Chlamydomonas media cell in the microchamber
Fig. 18. Cladosporium sphaerospermum, ALLINSON et al. (1973) (with kindly permission of M. S. LOVEDAY)

The efficiency of our technique was tested by comparing our results with those of ALLINSON et al. (1970) who used *Cladosporium sphaerospermum* spores in their investigations (see Fig. 18). The experiment was carried out with an environmental cell (static chamber, with single crystal corundum windows) in the AEI EM7 electron microscope at 1000 kV. During the experiment degradation (swelling and collapse) was observed as a function of current density. In spite of the fact that the *Cladosporium sphaerospermum* spores have rather thick cell walls, so their resistance are greater than that of *Chlamydomonas* cells with thin cellulose cell wall.

The microchamber can also be applied for different electron-optical experiments as shown in Table 1, accordingly, it offers new possibilities in many fields of research (see e.g. liquid electron diffraction in KÁLMÁN et al. 1974, 1977).

Table 1

APPLICATION

chemical		biological		
physical chemistry	atmospheric science	live cells	"in situ" studies	molecular biology
structural studies of water, electrolyte solutions and other liquids by electron diffraction	rain and smog nucleations	preventing structural modifications (drying)	radiation sensitivity of cells functions	ED. of wet protein crystals (conformation change with gases)
chemical reactions oxidation and other reactions at surface surface catalysis polymerisation		mobility studies (cytoplasmic streeming)	ecology toxicity of pollution gases to cells	ED. of wet natural and artificial membranes
		freezing studies	macromolecular interactions (myosin+actin)	
		space biology (gas bubbles in cells and plasma)	sensitive detection of tumor-specific antigen	
		cancer research (early detection)		

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THE ELEMENT ACCUMULATION IN SUBMERGED AQUATIC PLANT SPECIES IN LAKE BALATON

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The frequently occuring submerged aquatic plant species of lake Balaton (*Ceratophyllum submersum, Hydrocharis morsus ranae, Myriophyllum spicatum, Najas marina, Potamogeton pectinatus, P. perfoliatus, Stratiotes aloides, Utricularia vulgaris*) accumulate in their organism the studied biogenic elements and heavy metals (N, P, K, Mg, Na, Fe, Mn, Zn, Sr, Pb, Cu), in different amounts, depending on their cation-selective abilities and geochemical environment. Floating water plants are able to accumulate heavy metals to 10^3 order of magnitude nitrogen, playing a part in the eutrophication of the water of the lake, and phosphorus to 10^4-10^5. On the basis of the examinations, the biological indicator value of the individual species can be determined.

Introduction

From an ecosystem approach one of the important tasks of the lake-researches is the study of one of the producers of the lake-ecosystem. The quantitative and qualitative relations (chemical composition) of the submerged aquatic plants play in important part in the nutrient cycle, the changes in the trophication level of the individual components of the ecosystem, and in the nutrient balance.

According to the literature, the various aquatic plants accumulate in their organism considerable amounts of nitrogen and phosphorus, which play a part in the eutrophication of lakes (cf. ALLENBY 1968; BERNATOWICZ 1969; CAINES 1965; REAY 1972; STOKE 1967; 1968; TÓTH 1972; TÓTH-OLÁH and O. TÓTH 1975; WAGNER 1966; etc.). By accumulating heavy metals in their organism in a multifold amount (hundred and thousandfold) the individual oligo-elements and by reducing the toxic effects on the water of the lake, certain species of submerged aquatic plants guarantes life space of other living organisms as well (cf. ADAMS—MacKENZIF—COLE and PRICET 1972; ADAMS—COLE and MASSIE 1973; ANDERSON—BROWN and RAPPLEYE 1966; BOYD 1970; COWGILL 1974; ERIKSSON and MORTIMER 1975; DeMARTE and HARTMAN 1974; MATHIS and KEVERN 1975; MORTIMER and KUDE 1975; REAY 1972; STANLEY 1974; VOROBJEV and AFANASYEVA 1974; etc.).

The chemical composition and element accumulation by aquatic plant species is not only connected with the geochemical characteristics, chemical composition of the biotops (water) but also with the cation-selective ability of definite species to accumulate certain elements to a greater extent.

Material and methods

In 1976—1977 the following aquatic plant species were determined:

Ceratophyllum submersum, Hydrocharis morsus-ranae, Myriophyllum spicatum, Najas marina, Potamogeton pectinatus, P. perfoliatus, Stratiotes aloides, Utricularia vulgaris.

The sampling areas were as follows: Fonyód, Balatonberény, Gyenesdiás, Vonyarcvashegy, Balatongyörök, Szigliget, Badacsony, Révfülöp, Balatonszepezd, Balatonudvari, Tihany, Balatonfüzfő—Balatonkenese. The elements determined: K, Na (flame-photometer), Mg, Mn, Fe, Zn, Sr, Pb, Cu (Unicam atom-absorption spectrophotometer), N (KJEHLDAHL digestion), P (molybdenum reagent).

Free CO_2 is missing from the water of lake Balaton; the water plants of the lake cover their CO_2 demand from the $Ca(HCO_3)_2$ content of the water. $CaCO_3$ form a precipitate on water plants and the lime incrustation can hardly be removed from there. Therefore, the Ca-contents of the plants were not determined by us.

The concentration factor* (BOWEN 1956; FOSTER 1976; MORRIS and BALE 1975), and the discrimination factor** (FUKAI 1964; MAYRAUD and MARTIN 1975), which in the knowledge of the water of the lake Balaton (Table 1) and of the chemical compositions of the individual aquatic plants (Table 2) were calculated by us, are known from the literature on algae.

$$* \text{ Concentration factor} = \frac{\text{element content related to the dry weight of the plant, in ppm}}{\text{element content in water in } \mu g/ml}$$

$$** \text{ Discrimination factor} = \frac{X/Y \text{ in the plant dry matter content}}{X/Y \text{ in the water}}$$

X and Y are the two elements compared. The discrimination factor expresses the quantitative connection between the two elements, by taking into consideration the ratio of the two elements in the water.

Occurrence of poly- and oligo-elements in water plants

Nitrogen

Nitrogen occurs in the greatest quantity in the *Najas marina* species (3.02%), *Ceratophyllum submersum* (2.5%), *Hydrocharis morsus-ranae* (2.51%) and *Utricularia vulgaris* (2.44%). These aquatic plants inhabit littoral-zone the shallow in reeds, where—as a result of the great organic matter production — the nutrient quantity which can be taken up and the nitrogen quantity is considerably greater than that in the open water of lake Balaton.

In the typical aquatic plants of the open water of the lake (*Myriophyllum spicatum*, *Potamogeton pectinatus*, *P. perfoliatus*), the average values of the nitrogen content are between 1.44 and 1.83%.

A correlation can be detected between the nitrate-nitrogen content of the water of the lake and the N-content of the individual aquatic plants (Figs 1—3).

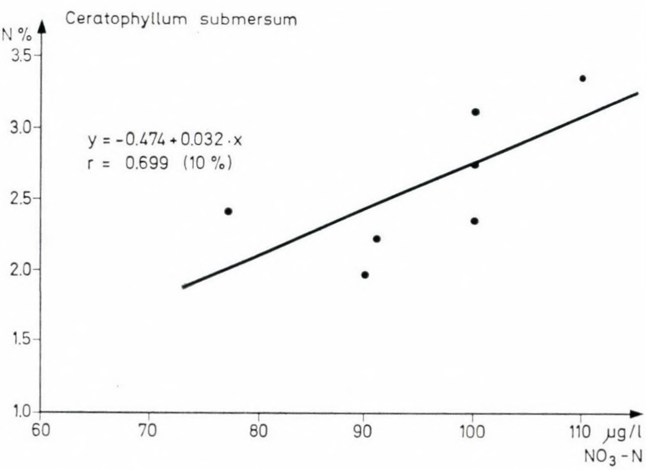

Fig. 1. Correlation between the NO_3-content of water and the N-content of *Ceratophyllum submersum*

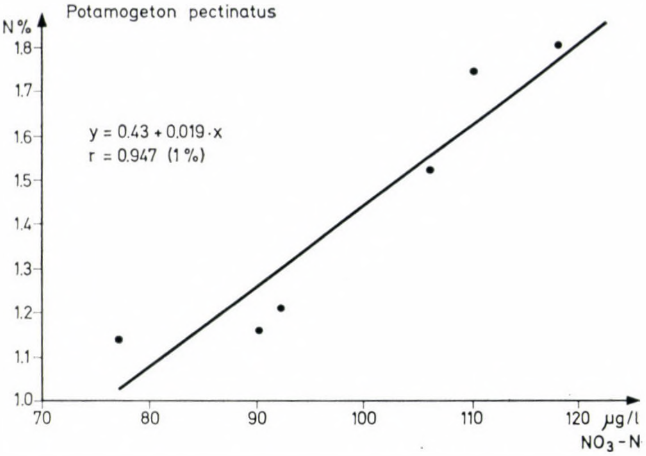

Fig. 2. Correlation between the NO_3—N-content of water and the N-content of *Potamogeton pectinatus*

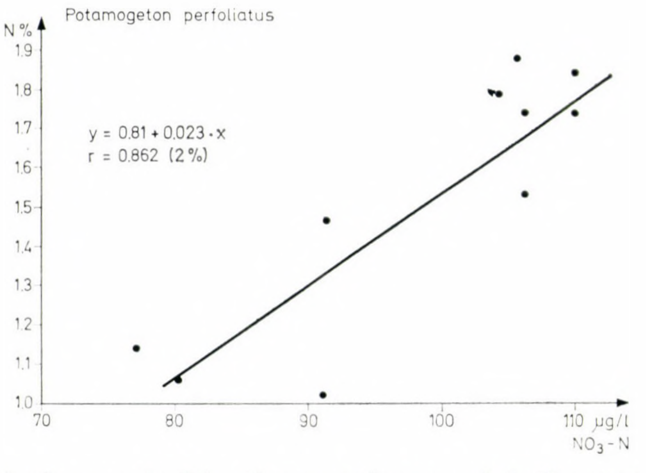

Fig. 3. Correlation between the NO_3—N-content of water and the N-content of *Potamogeton perfoliatus*

With regard to nitrogen, a sensitive biological indicator is for example the *Ceratophyllum submersum*. In the bays of Keszthely and Szigliget, where the total nitrogen and nitrate-nitrogen content of the lake is the greatest (cf. Table 1), the nitrogen content of the leaf plant is over 3%. According to the data of Tóth (1972) where refuse water flows into the lake the nitrogen content of the aquatic plants doubles.

The aquatic plants of the open water in the area of the coves of Keszthely and Szigliget also contain more nitrogen. Thus, the nitrogen content of the *Potamogeton perfoliatus* species obtained from those areas was 1.53—1.84%, and in areas where the nitrogen content of the water is lower, the plant contains only 1.02—1.14% nitrogen.

Table 1

Chemical composition of the water of lake Balaton

Sampling place	N, mg/l	NO_3-N μg/l	PO_4-P, μg/l	Mg, mg/l	K, mg/l	Na, mg/l	Fe, μg/l	Mn, μg/l	Zn, μg/l	Cu, μg/l
Keszthely	1.215	106	7.7	38	5.5	21	340	57	50	8
Szigliget	0.975	104	6.7	38	5.1	18	350	41	10	7
Badacsony—Fonyód	0.985	99	6.7	39	5.5	20	325	35	10	2
Révfülöp—Balatonboglár	0.967	90	5.5	41	5.5	20	220	21	20	2
Balatonszemes	0.795	77	4.1	42	5.5	20	200	17	20	2
Cove of Bozsa—Balatonföldvár	0.683	61	4.1	43	5.5	20	—	—	—	—
Tihany	0.743	91	4.1	44	5.7	20	—	—	—	—
Balatonfüred—Siófok	0.627	101	3.5	44	5.9	22	200	11	20	7
Balatonfűzfő	0.629	92	5.7	45	5.9	22	255	15	10	4

N, NO_3-N, PO_4-P, Mg, Fe, Mn, Zn, Cu-data: Scientific Research Institute for Water Economy, 1973—1975; K, Na-data: NÉMETH and PÁSZTÓ 1976.

Potassium

The water of the lake contains only potassium in a relatively small amount (5.1—5.9 mg/l; see Table 1); it is accumulated by the aquatic plants to 10^3 order of magnitude, which is a considerably higher than the magnesium or natrium accumulated (see later). The potassium-accumulation by aquatic plants is primarily a species characteristic and it is to a lesser extent dependent on the geochemical environment *Stratiotes aloides* contains it in the highest amount (4.25%); in *Ceratophyllum submersum* and *Hydrocharis morsus-ranae* its quantity is above 2%. A smaller quantity of potassium content is also characteristic of such aquatic plants of open waters (cf. Table 2).

Table 2

Element content of aquatic plant species

Serial number	Name of the plant species	Number of samples	Ashes	K	Na
			%		
1.	*Ceratophyllum submersum*	11	19.2	2.33	0.63
2.	*Hydrocharis morsus-ranae*	9	19.0	2.25	1.14
3.	*Myriophyllum spicatum*	11	20.01	1.20	1.04
4.	*Najas marina*	3	17.13	1.51	0.65
5.	*Potamogeton pectinatus*	7	23.14	1.47	0.52
6.	*P. perfoliatus*	14	21.8	1.06	0.49
7.	*Stratiotes aloides*	7	25.6	4.23	1.00
8.	*Utricularia vulgaris*	8	22.9	1.99	1.01

Magnesium

The water of lake Balaton which is a water with Ca-Mg-hydrocarbonate contains the average 38—45 mg/l Mg (Table 1). The quantity of magnesium is increasing along the south-western (cove of Keszthely) and north-eastern (Balatonfüzfő) axis, while calcium occurs in a decreasing quantity (NÉMETH—PÁSZTÓ 1976). This west-east directional change in the magnesium content is also indicated by the chemical composition of *Potamogeton perfoliatus*, the most common characteristic aquatic plant of the lake. According to our sampling in 1976, the magnesium content of the aquatic plant in the areas of Keszthely and Szigliget was 0.58—0.84%, and in the areas of Balatonszepezd and Tihany it was 0.88—0.90%; the Mg-content of the plant increases parallel with that of the water of the lake.

The plants examined accumulate this element to the order of magnitude 10^2. A greater quantity of Mg-content is characteristic of the aquatic plants of the littoral-zone (Table 2); *Stratiotes aloides* (cf. ULEHLOVA 1971) contains a quite considerable amount of it.

Natrium

Besides calcium and magnesium, a large amount of natrium is also present in the water of lake Balaton (see Table 1); it is accumulated by the aquatic plant species and found to an extent of 10^2 order of magnitude.

Hydrocharis morsus-ranae, *Myriophyllum spicatum*, *Stratiotes aloides* and *Utricularia vulgaris* contain about 1% natrium.

Phosphorus

The ortho-phosphate quantity of the water of the lake (PO_4-P) is between 3.5 and 7.7 μg/l; considerable amount of it can be measured in the western basin of lake Balaton (Keszthely—Szigliget—Badacsony—Fonyód). The various aquatic plant species contain 0.17—0.31% phosphorus on the average. More is found in *Ceratophyllum submersum;* in the samples obtained from the loaded lake-shore sections 0.62% can also be detected. This element is accumulated by the floating-leafed species at 10^5 order of magnitude. In the eutrophication of the water of the lake, phosphorus and nitrogen play a significant part; the different aquatic plant species are able to accumulate these elements at 10^5 and 10^4 orders of magnitude. It is here that the aquatic plants play an important part in the life of the lake (especially in that of a charged lake). They cut out the two elements from the geochemical cycle for a definite period of time (vegetation period); but it should be noted that the two elements continue to be present as a potential load in the water of the lake.

in relation to the dry matter

Mg	P	N	Mn	Fe	Zn	Sr	Pb	Cu
			ppm					
0.94	0.31	2.54	985	1206	204	21	21	12
1.18	0.25	2.51	464	1077	174	35	43	19
0.58	0.24	1.86	463	1187	146	92	24	9
0.50	0.26	3.02	427	1453	227	68	11	9
0.69	0.17	1.44	387	2030	97	152	36	7
0.79	0.22	1.52	120	1112	116	172	21	10
1.29	0.19	1.72	459	342	156	146	23	7
0.87	0.21	2.44	998	1783	185	57	29	13

According to the literature (Tóth, Oláh and O. Tóth 1975), the phosphorus stabilization of the aquatic plants is significant. According to the investigations carried out in 1969—1970, the stand of aquatic plants in the coves of Keszthely and Szigliget (75 000 kg of dry matter) tied down 225 kg of phosphorus.

Iron

The water of the lake contains iron in the highest amount among microelements (200—350 μg/l; Table 1); values above 300 μg/l are characteristic of the Keszthely—Szigliget—Badacsony—Fonyód area. The concentration factor of iron in the floating species is 10^3 order of magnitude.

Two of the water plant species is remarkable with regard to iron content; *Potamogeton pectinatus* contains it in a value of 2000 ppm, but according to our data, this element can be measured in the samples obtained from the Keszthely—Szigliget—Badacsony area — where the Fe content of the water of the lake is above 300 μg/l — in a value of about 3000 ppm.

A small quantity of iron content is characteristic of *Stratiotes aloides.* The plant contains it in 342 ppm on the average; in the sample obtained from the cove of Keszthely only 111 ppm could be measured.

Manganese

It occurs in the water of the lake in 11—57 μg/l amount, and similarly to the quantitative occurence of iron, more can be detected in the western basin of the lake (cf. Table 1).

With respect to manganese accumulation, two species can be emphasized, *viz. Ceratophyllum submersum* and *Utricularia vulgaris*; both species contains it in a value above 900 ppm, and in some of the plants a value of 3000 ppm has also been detected.

A relatively small Mn-content is characteristic of *Potamogeton pectinatus* and *Potamogeton perfoliatus.* In spite of this Mn content, *Potamogeton perfoliatus* indicates the changes in the Mn-content of the water of lake Balaton by its chemical composition. Parallel with the decreasing Mn-content of the water in the direction of Southwest-Northeast, the Mn-content of the plant also decreases. In the line of the cove of Keszthely and Szigliget and Révfülöp, the Mn-content of the aquatic plant species was between 104 and 211 ppm; to the east from Balatonszepezd, only 95—48 ppm values were measurable.

Zinc

The zinc content of the water of the lake is 10—20 μg/l; in the cove of Keszthely it is 50 μg/l.

A fungicide "Zineb", may reach the vineyards of the Balaton-region by their being sprayed from air planes and it can be supposed that in the form of aerosol of by erosion it gets from these areas into the water of the lake. Zinc has been detected in largest amount in the aguatic plants of the lake-shore band, as for example in *Ceratophyllum submersum, Hydrocharis morsus-ranae, Najas marina, Utricularia vulgaris.* Also in the aquatic plant species mentioned, Zn can be detected where there are larger extensions of vineyard areas, in the vicinity of the lake shore band of the Balaton.

The aquatic plants accumulating Zn at an order of magnitude 10^3 reduces the toxicity of zinc. For the *Gammarus* species, Zn reaching the water is toxic in even a relatively small amount (Herbst 1966).

Copper

The water of the lake contains only 2—8 μg/l of copper; it can reach the Balaton also from sprayed vineyard areas, with the fungicide containing zinc (blue vitriol, "Cupromix"). This has been supported by our investigations, in the *Ceratophyllum submersum* (31 ppm), *Hydrocharis morsus-ranae* (34 ppm), *Utricularia vulgaris* (24 ppm) samples, copper could be detected in greater amounts than in those obtained from other habitats in the Balaton.

Strontium, lead

Strontium accumulation is a characteristic mainly of *Potamogeton* species* (Table 2), but *Stratiotes aloides* can also be classified as belonging here.

Lead has been detected in a relatively greater amount in *Hydrocharis morsus-ranae* and *Potamogeton pectinatus*, especially in the samples obtained from the area around Tihany—Balatonfüred.

Conclusions and summary

An important biogeochemical function of plant species is the changing geochemical environment (by the concentration and scattering of elements). It is on the basis of the following characteristics that aquatic plant species can also influence the water qualities:

— The plant accumulates certain elements selectively in its organism, and thus the phytomass contains them in a greater amount than does the surroundings. Geochemical importance is attributed to mainly those elements which are capable of being accumulated in the living organism in a quantity ten times, hundred times and even thousand times greater than that occuring in the environment.

— If, in a geochemical environment, an element occurs in a great concentration and this is accumulated also in the phytomass, the rate of accumulation depends on the geochemical characteristics of the biotops.

In the submerged aquatic plant species of the Balaton, both biogeochemical characteristics — which are often difficult to separate — can be found. Information on the element accumulation characteristic of water plant species is given in Table 3.

The various water plant species contain the individual elements not only in different quantities but also in different orders of magnitude (Table 4).

Knowing of the chemical composition or element content of the water of the lake, we calculated the concentration factor of the elements examined in the floating plants (Table 5). The individual plant species can for a certain time accumulate nitrogen and phosphorus primarily playing a part in the eutrophication of the water — at orders of magnitude 10^4 and 10^5. The oligo-elements and heavy metals occuring in a small quantity in the geochemical environment accumulate at an order of magnitude 10^3; magnesium and natrium, occuring in greater amounts in the water, is measurable in the plants at an order of magnitude 10^2.

By the discrimination factor calculated for the various element pairs we can determine what elements are preferred by the individual floating plants (Table 6). Thus for example, *Stratiotes aloides* prefers K to Na, and manganese to Fe, or Sr to Mg. The chemical differences in the individual plant species can also be read from the discrimination factors.

* According to our further examinations, *Potamogeton crispus* is also a kind of species accumulating Sr.

Table 3

Element accumulation in aquatic plant species

	N	P	K	Na	Mg	Fe	Mn	Zn	Sr	Pb	Cu
Ceratophyllum submersum	+	+	+				+	+			
Hydrocharis morsus-ranae	+		+	+	+			+		+	+
Myriophyllum spicatum				+				+			
Najas marina	+					+		+			
Potamogeton pectinatus				+		+			+	+	
P. perfoliatus				+					+		
Stratiotes aloides			+	+	+				+		
Utricularia vulgaris	+						+	+			

Table 4

Order of element accumulation in aquatic plant species

Ceratophyllum submersum	N	> K	> Mg	> Na	> P	> Fe	> Mn	> Zn	> Sr	= Pb	> Cu
Hydrocharis morsus-ranae	N	> K	> Mg	= Na	> P	> Fe	> Mn	> Zn	> Pb	> Sr	> Cu
Myriophyllum spicatum	N	> K	> Na	> Mg	> P	> Fe	> Mn	> Zn	> Sr	> Pb	> Cu
Najas marina	N	> K	> Na	> Mg	> P	> Fe	> Mn	> Zn	> Sr	> Pb	> Cu
Potamogeton pectinatus	N	> K	> Mg	> Na	> P	> Fe	> Mn	> Sr	> Zn	> Pb	> Cu
P. perfoliatus	N	> K	> Mg	> Na	> P	> Fe	> Sr	> Mn	> Zn	> Pb	> Cu
Stratiotes aloides	K	> N	> Mg	> Na	> P	> Mn	> Fe	> Zn	> Sr	> Pb	> Cu
Utricularia vulgaris	N	> K	> Na	> Mg	> P	> Fe	> Mn	> Zn	> Sr	> Pb	> Cu

Table 5

Concentration factor of element in floating aquatic plants (Hydrocharis morsus-ranae, Stratiotes aloides, Utricularia vulgaris) in relation to the chemical composition of the water of lake Balaton

P*	10^5
N**	10^4
Mn	10^4
K	10^3
Fe	10^3
Zn	10^3
Cu	10^3
Na	10^2
Mg	10^2

* In relation to the PO_4-P-content of the water.
** In relation to the total N-content of the water.

Table 6

Discrimination factor for the various element pairs

	Na/K	Mg/Sr	Mn/Fe	Mn/Cu	Mn/Zn	Fe/Cu	Fe/Zn	Cu/Zn
Hydrocharis morsus-ranae	0.14	2.70	4.18	3.92	1.90	0.94	1.07	0.48
Stratiotes aloides	0.06	0.71	13.03	10.54	2.10	0.81	0.16	0.20
Utricularia vulgaris	0.14	1.22	5.43	12.34	3.85	2.28	0.71	0.31

The poly- (K, Na, Mg, P, N) and oligo-elements (Fe, Mn, Zn, Sr, Pb, Cu) are contained in different quantities in the individual plant species, namely the total element contents are different in the species examined. The poly-element content of the plant species of the littoral zone (*Ceratophyllum submersum, Hydrocharis morsus-ranae, Najas marina, Stratiotes aloides, Utricularia vulgaris*) is higher (5.94—8.45%) than that of the plant species in the open water (*Myriophyllum spicatum, Potamogeton pectinatus, P. perfoliatus*; 4.08—4.92%; Table 7).

One of the most dangerous aquatic plant species of the Balaton, *Stratiotes aloides* is especially rich in elements; both by its chemical composition and great phytomass volume, it accelerates the accumulations processes in the littoral zone of the lake. This plant species wich has become rapidly spreading recently, differs from the frequently occuring plant species of the Balaton also by its chemical composition (it accumulates primarily the alkali metals and the alkali earth metals).

The emerging of aquatic plant species in the lake, their mass occurence, is *not the cause* but the consequence of the loading which reaches the water of the lake.

Table 7

Quantity of poly- and oligo-elements in the aquatic plant species in lake Balaton

	Σ K, Na, Mg, P, N, %	Σ Fe, Mn, Zn, Sr, Pb, Cu, ppm
Ceratophyllum submersum	6.75	2449
Hydrocharis morsus-ranae	7.33	1812
Myriophyllum spicatum	4.92	1921
Najas marina	5.94	2195
Potamogeton pectinatus	4.29	2709
P. perfoliatus	4.08	1551
Stratiotes aloides	8.43	1133
Utricularia vulgaris	6.52	3065

The aquatic plant species emerging as constant concomitants in the reeds of the littoral zone (*Ceratophyllum submersum, Hydrocharis morsus-ranae, Najas marina, Utricularia vulgaris*, etc.) fix 2—3% of the nitrogen, and accumulate a considerable quantity from the nitrogen charge coming from the direction of the shore, and from the water of the lake-shore band rich in nutrient material, and they "filtrate" the water of the lake.

The aquatic plants of the open water (*Myriophyllum spicatum, Potamogeton pectinatus, P. perfoliatus*), with a nitrogen contents around 1.5%, extract by their great phytomass volume a considerable quantity of N and other elements from the open water of the lake, for a certain time, thus, the nutrients which reached the lake-ecosystem become reserved.

By their element-accumulating abilities, the aquatic plants play a significant part in the biological cleaning of the water, and in reducing the toxic effect of certain heavy metals.

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COMPARATIVE ANALYSIS OF BIOTECTON (PERIPHYTON) SAMPLES COLLECTED FROM NATURAL SUBSTRATE IN WATERS OF DIFFERENT TROPHIC STATE

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Comparative taxonomical and biomass analyses of biotecton samples taken from natural substrate — *Typha latifolia* L. — of waters of different trophic state were carried out in the autumn of 1974.

On the basis of our experimental data it can be stated that the composition of the biotecton taken from the natural substrate is in correlation with the trophic state of the given water body and that the greatest species diversity can be found in the impendment of Oláhrét having meso-eutrophic state.

The qualitative and quantitative composition of the phyto- and zootecton taken from the eutrophic fishpond of Polgár is very similar to that found in the meso-eutrophic conditions. In the water of the oligotrophic lake of Nyékládháza, the small number of algae species and individuals, as well as the larger biomass — in comparison with the higher degree of trophic state in the other three water bodies — are characteristic of the biotecton.

In the waters of nutrient enrichment and planktonic eutrophication — the phytotecton similarly to the macrophytes — is stroyly reduced and; owing to the environmental factors becoming unfaronrabe. This indicates not only a trophic state but also an autosaprobitic one. From the decrease in species diversity, and from our cluster analysis results, it can be inferred that the composition of the biotecton taken from the polytrophic water of the fishpond of Hortobágy is to a large extent different from that found in mesotrophic-eutrophic ponds.

Introduction

For an accurate study of the trophic state of an aquatic ecosystem, the examination of the biotecton (periphyton) is important. The part played by this characteristic biocenosis in changing and indicating the quality of the water can only be understood by studying several types of water which differ from one another essentially.

The significant part played by the benthonic plant complex — that is the macrophyte and the attached epiphitic phytotecton — together with the phytoplankton in the primary production of the aquatic ecosystem has been analysed, in the papers among others, by ALLEN (1971), HARGRAVE (1969), STRASKRABA (1963) and WETZEL (1964). This is especially so in small and shallow waters; in DICKMAN's words (1968): "*In many small lakes the algal periphyton may be a major contributor of fixed carbon (energy).*" With respect to shallow waters of Hungary (fishponds and impondments), the examination of this question is still in the initial phase only, nevertheless, the prospects for solving this task are promising.

The intensive enrichment is nutrients of our waters may be accompanied by an intensive biotecton formation, and the "proliferating", long-threaded, ribboned forms may disturb the use of water, do not offer a pleasant view aesthetically, furthermore, may disfavourably influence the quality of deeper water-layers. The endeavours started abroad which, on the basis of the results obtained from taxonomical, biomass-productional and chemical-energetical investigations into the biotecton, classify the ponds into types according to their trophic state (BUTCHER 1946; PIECZYNSKA 1970; SZCZEPANSKI 1968, etc.).

In our days, eutrophication is the most significant and most general among anthropogenic damages caused in our waters. In the life of waters, eutrophication is such a natural successional process the most remarkable feature of which is the mass growth plant life in the aquatic ecosystem. If we want to know the rapidity and direction of the changes ensuing in the course of eutrophication of waters, we must evaluate the present situation, as far as possible, from all biological aspects. In this way, notwithstanding the fact that the problem of such a scope of examinations into biotecton organisms is still rather neglected, we can approach this complex set of problems more closely.

In this paper the comparative taxonomical and biomass investigations into the biotecton samples taken from the natural substrate of water bodies of different trophic state will be reported — from *Typha latifolia* L. —, which was carried out in the autumn of 1974.

Investigation sites

1. The gravel pit of Nyékládháza (Ny). — The gravel **pit** of the ballast-digging at Nyékládháza lie in a SE direction, at a distance of a few kilometres from the village. From a hydrological point of view, the gravel pits are "closed basins", without inlet and outlet, thus, their water supply is clearly of a moisture and mainly groundwater origin. The water body examined is the last member of the gravel pits lying on the southern side of roadway No. 35. Its area is about 10 ha, at its deepest points a water-column of even 8—10 m was measured.

In the shallower water near the shore, in accordance with its successional stage, the submersed vegetation and the stand of *Typha latifolia* L., which settled in spots, are significant. The biotecton sampling sites were marked at the NW end of the pond, near the roadway, in the stand of *Typha latifolia* L.

2. The impondment of Oláhrét (O). — This was made in 1964, to the south of Császárszállás. The average area of the impondment in 60 ha, the deepest point of its water is 3.2 m, its average depth is 1.0—2.5 m. Its water exchange is regulated according to the irrigation requirements of the surrounding areas.

In the shallow parts of the impondment, the littoral vegetation is quite extensive. Alternatively, stands of *Phragmites australis* (Cav.) Trin. ex Steud and of *Typha latifolia* L. occur, and again of the submersed pondweed vegetation the *Myriophyllum spicatum* L. and *Ceratophyllum demersum* L. species can be emphasized. Our sampling area was marked in the *Typha latifolia* L. stand occuring in the Nagyrét branch of the impondment, near the NE shore.

3. A fishpond of Polgár (P). — The fishponds of Polgár lie in the northern part of one of the small areas of the Middle-Tisza region, the Hortobágy. The examined fishpond lies immediately alongside the roadway between Polgár and Tiszafüred, on the western side of the roadway. Its area is some 30 ha, the average depth of water is between 0.8 and 1.5 m.

The fishpond is lined by a large band of bulrush. The productivity of the pond is attempted to be increased by an intensive fertilization of combined farmyard manure and chemical fertilizer. The biotecton samplings were taken from the bulrush stand along the northern shoreline perpendicular to the roadway.

4. A fishpond of Hortobágy (H). — The fishpond examined by us (its local name is pond Derzsi) is a member of the Ohat pondgroup of the fishponds of Hortobágy. It lies immediately by the roadway No. 33, to the north of it. Its area is some 120 ha. The average depth of water is between 0.8 and 2.0 m. Its water exchange is determined by current viewpoints of fishery economy.

The fishpond is lined by a band of bulrush, reed and club-rush. The shallower, mainly littoral water, is rich in stands of pondweed. The biotecton samplings were taken from the *Typha latifolia* L. stand near the access road branching off roadway No. 33.

Materials and methods

Collecting samples from the bottom-dwelling communities and biotectons is one of the most difficult tasks in hydrobiology (Forsberg 1959; Juday 1924; Wood and Hargraves 1969). This is especially true with respect to sampling from natural substrates.

The biotecton samples taken from bulrush for studying the quality of water were delivered in glass-tubes — filled with tapwater at the site — into the laboratory where they were then processed. The biotecton was scraped off thoroughly from the bulrush with an algae-scraper and then detailed biomass and taxonomical examinations were carried out on the specimens. Although there were samplings on three occasions and we worked on a basis of double repetition, here only the cumulated results will be presented.

Plankton samples were collected by ladling the surface water from the neighbourhood of the bulrush stand. In the course of sampling we measured the water depth, the transparency (Secchi disc), the temperature, and the conductivity of the water in a RADELKIS OK 102/1-type conductometer of the laboratory. The determination of the nitrogen content, and phosphorus-forms in the water, and of the phytoplankton chlorophyll content, was based on the work of FELFÖLDY (1974).

The determination of the exact wet weight of aquatic organisms and biotic communities is impeded by the water adhesing to their body, therefore, the wet weight value can be used only for the determination of the dry matter weight. The biomass of the biotecton specimens is also given in respect of the dry weight; the biomass had previously been dried at 105 °C. The determination of the ash-free dry weight the organic matter content was carried out in the usual way by putting it into the heating furnace at 600 °C (RAVANKO 1972).

The number of planktonic plant organisms is related to one liter, while the phytotecton members of the biotecton to an area of 1 cm². The zooplankton results are related to 10 liters, and again the number of zootecton organisms to 100 cm².

Results and discussion

In the literature, several authors are of the opinion (BOHR 1962; HILLBRICHT-ILKOWSKA et al. 1972; PIECZYNSKA 1970; SZCZEPANSKA 1970; etc.) that for ecological and production biological investigations the biotecton gathered in the autumn is the most suitable, therefore, we also used the biotecton collected in September and October. The plankton analysis results given in Table 1 contain only the most important of those obtained from the examinations carried out. The summary results of the biotecton examinations are presented in Tables 2 and 3.

Table 1

The most important results of chemical and biological analyses into the water bodies examined in September 1974

		Nyékládháza	Oláhrét	Polgár	Hortobágy
Water depth (cm)		160	40	60	80
Transparency (cm)		150	30	20	10
Water temperature, C°		18.0	16.5	17.0	17.1
Conductivity, μS		486.6	596.9	465.9	387.9
Nitrate-N	N mg/l	0.064	0.084	0.066	0.064
Nitrite-N	N mg/l	0.000	0.000	0.000	0.000
Ammonia-N	N mg/l	0.118	0.441	0.409	0.331
Inorganic bound-N	N mg/l	0.182	0.525	0.475	0.395
Organic bound-N	N mg/l	0.680	4.094	2.205	4.393
Total-N	N mg/l	0.862	4.619	2.680	4.788
Dissolved ortho-P	P mg/l	0.003	0.012	0.025	0.017
Total dissolved-P	P mg/l	0.043	0.127	0.082	0.110
Total P	P mg/l	0.086	0.341	0.341	0.582
Plankton chlorophyll-a	mg/m³	8.34	139.15	142.52	263.80
Plankton total chlorophyll	mg/m³	11.50	186.50	198.66	363.34
Total alga count (ind $10^6 \cdot$ liter^{-1})	mg/m³	1.08	183.02	174.41	467.59
Total zooplankton count (ind. 10 l^{-1})		987	8004	30 968	29 056

Table 2

The results of processing the biotecton collected from the Typha latifolia L. of water bodies with different trophic state September 1974

10^8 ind./cm^2	Nyékládháza	Oláhrét	Polgár	Hortobágy
Phytotecton				
Cyanophyta	58.4	91.3	161.0	192.0
Chamaesiphon incrustans Grun.	—	+++	+++	++
Chamaesiphon oncobyrsoides Geitl.	—	—	+	—
Chroococcus minutus (Kg.) Näg.	+	—	—	—
Gloeocapsa sp.	+	—	—	—
Lyngbya kützingii Schmidle	+++	—	++	+++
Lyngbya limnetica Lemm.	—	++	—	—
Microcystis parasitica Kg.	++	—	—	—
Oscillatoria trichoides Szafer	—	—	—	+
Phormidium sp.	+	+	—	—
Schizothrix cuspidata W. et G. S. West	—	—	—	+
Stigonema minutum (Agh.) Hassal	+	—	—	+
Eugenophyta	0.0	7.9	0.0	0.0
Phacus pleuronectes (Ehr.) Duj.	—	+	—	—
Xanthophyceae	3.3	0.0	10.6	0.0
Botrydium sp. ?	+	—	—	—
Pseudocharacium sp.	—	—	+	—
Bacillariophyceae	22.7	150.8	206.9	130.8
Achnanthes minutissima Kütz.	++	—	+	+
Achenanthes ovalis Kütz.	+	—	—	+
Cocconeis placentula (Ehr.)	—	+	++	—
Cymbella lanceolata (Ehr.) Van Heurck	—	+	—	—
Cymbella turgida (Greg.) Cleve	—	+	—	—
Cymbella ventricosa Kütz.	—	+	+	—
Epithemia zebra (Ehr.) Kütz.	++	—	—	—
Epithemia sorex (Kütz.	—	+++	—	—
Gomphonema acuminatum (Ehr.)	—	—	—	+
Gomphonema constrictum (Ehr.)	—	+	—	—
Gomphonema lanceolatum (Ehr.)	—	+	—	—
Gomphonema olivacaeum (Lyngb.) Kütz.	—	++	++	—
Melosira granulata (Ehr.) Ralfs	—	+	—	—
Navicula cryptocephala Kütz.	—	++	—	+
Navivula exigua (Gregory) O. Müll.	+	—	—	——
Nitzschia kützingiana Hilse	+	—	—	++
Nitzschia palea (Kütz.) W. Sm.	+	+	+	+
Rhoicosphaenia curvata (Kütz.) Grun.	—	+++	+++	—
Surirella ovata Kütz.	—	++	—	+
Synedra ulna (Nitzsch.) Ehr.	—	++	—	+
Chlorophyta	97.9	39.7	52.9	60.5
Actinastrum hantzschii Lagerh.	—	+	+	—
Ankistrodesmus acicularis (A. Br.) Korsch.	—	+	+	—
Cladophora sp.	+++	+++	+	—
Crucigenia tetrapedia				—
(Kirchn.) W. et G. S. West	—	+	—	—
Lagerheimia genevensis Chod.	—	+	—	—

Continued Table 2

10^3 ind./cm^2	Nyékládháza	Oláhrét	Polgár	Hortobágy
Oocystis lacustris Lemm.	+	—	—	—
Pediastrum duplex Meyen	+	+	+	—
Pediastrum simplex (Meyen p. p.) Lemm.	—	—	—	+
Protococcus viridis Agh. (ú)	+	—	—	—
Scenedesmus acuminatus (Lagerh.) Chod.	—	+	—	+
Scenedesmus quadricauda (Turp.) Bréb.	+	+	+	—
Scenedesmus spinosus Chod.	—	+	—	—
Staurastrum paradoxum Meyen	—	+	—	—
Tetraedron minimum (Al. Braun) Hansg.	+	—	—	+
Trentepohlia sp.	—	—	—	+
Total organism	182.3	289.7	431.4	383.3
Ind./100 cm				
Zootecton				
Protozoa				
Acineta sp.	—	21	—	—
Epystilidae	72	3013	2170	128
Holotrichidae	—	69	—	—
Vorticella sp.	—	69	—	—
Platyhelminthes				
Dugesia sp.	2	—	—	—
Nemathelminthes				
Rhabditidae	1484	62	798	69
Rotatoria				
Bdelloidea	360	560	238	395
Brachionus rubens (Ehr.)	—	—	98	—
Brachionus sp.	36	493	—	—
Lecane sp.	34	20	13	—
Lepadella patella (O. F. Müll.)	—	71	—	—
Annelida				
Hirundinoidea				
Erpobdella octoculata (L.)	—	1	—	—
Haementeria costata (Fr. Müll.)	—	1	—	—
Bryozoa				
Plumatella repens (L.)	—	57	—	—
Crustacea				
Cladocera Alona sp.	4	6	15	13
Ostracoda	—	—	74	—
Copepoda				
Cyclopoida	6	7	—	10
Copepodit	7	10	32	—
Insecta				
Plecoptera	—	—	2	—

Continued Table 2

ind./100^2cm^2	Nyékládháza	Oláhrét	Polgár	Hortobágy
Diptera				
Chironomidae < 0,5 cm	7	22	2	3
Chironomidae > 0,5 cm	—	5	—	—
Tabanidae	—	—	6	—
Arachnoidea				
Argyroneta aquatica (Clerck)	—	—	1	—
Hydracarina	3	1	—	—
Mollusca				
Acroloxus lacustris (L.)	—	—	5	—
Total organism	2015	4488	3454	618

Table 3

Biomass values of biotecton (phyto- and zootecton) collected from the Typha latifolia L. of water bodies with different trophic state, September 1974

mg/10cm^2	Dry weight	Ash free dry weight	Ash weight
Nyékládháza	21.49	9.12	12.27
Oláhrét	10.02	3.20	6.82
Polgár	9.77	3.78	5.99
Hortobágy	7.70	4.05	3.65

On the basis of the factors determining the potential side of the eutrophication — that is, the quantity of the plant nutrients (nitrogen and phosphorus) and the number of the phytoplankton as well as the concentration of chlorophyll — the water of the gravel pit at Nyékládháza is oligotrophic, in comparison with the meso-eutrophic character of the water of the impondment of Oláhrét, of the two fishponds, the water of the fishpond at Polgár is eutrophic and again the polytrophic state and a planktonic eutrophication is characteristic of the water of the fishpond of Hortobágy (Szabó et al. 1974).

The distribution of the planktonic algae is demonstrated in Fig. 1. As can be seen from the figure, the dominance of *Cyanophyta* and *Chlorophyta* is characteristic of the waters of high trophic state. The value of distribution of phytotecton organisms (Figs 1 and 2) is to a certain extent different from that

obtained from the phytoplankton analysis, although the number of individuals is in agreement with the values expected on the basis of the trophic state.

Butcher (1946), who examined the distribution of the periphyton (biotecton) of the rivers in England for 15 years, and who evaluates the biotecton qualitatively and quantitatively in the grades of eutrophic state, has given the following numerical values:

eutrophic pond	2500—10 000 ind./mm²
oligotrophic pond	2 000 ind./mm² and below

Naturally, the above values only clarify the problem broad outlines.

Butcher's results (1946) have been confirmed by the measurements of Pieczynska and Szczepanska (1966) on the basis of which the number of

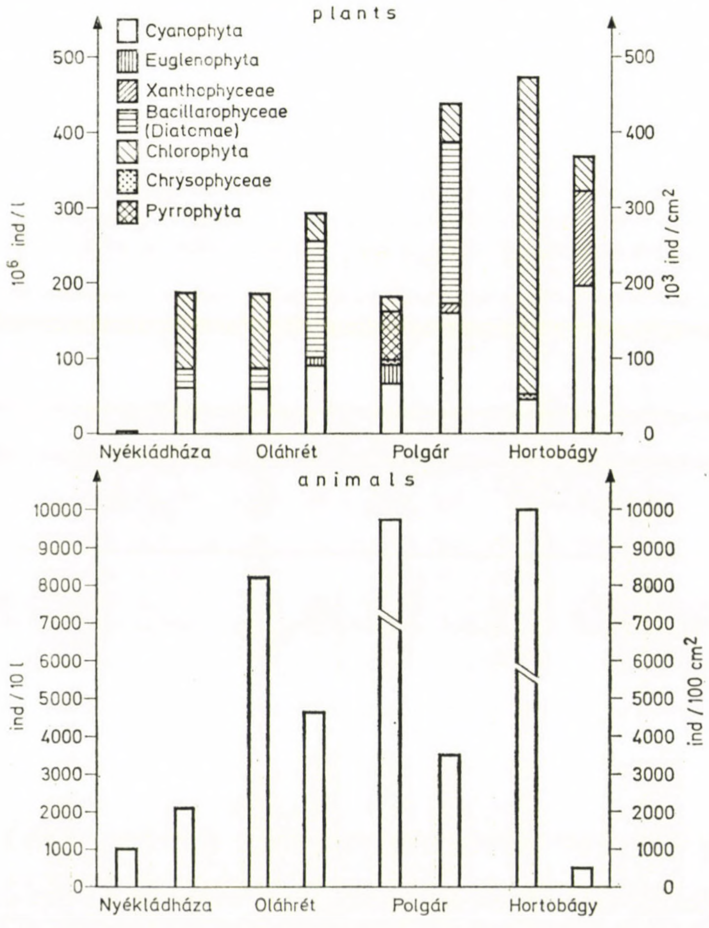

Fig. 1. The quantity of plankton and biotecton (phyto-zoo) organisms collected from the *Typha latifolia* L. stands of water bodies with different trophic state in September, 1974 First column: phytoplankton and zooplankton respektively; Secord column: phytotecton and zootecton respectively

phytotecton individuals is greater in waters having greater trophic state. Our examinations partly testify this too; the value of phytotecton gathered from pond Nyékládháza falls below these values mentioned above. However, the problem is not so simple and does not give such unambiguous results if the qualitative composition is also analysed and the zootecton organisms are also taken into consideration. As against the three other water bodies, the *Chlorophyta* phylum is dominant only in the pond of Nyékládháza. In accordance with the autumn aspects, the great number of filamentous *Cyanophyta* (STROCKNER and ARMSTRONG 1971) is generally characteristic, but the small-sized diatom algae, mainly in the samples taken from the impondment of Oláhrét and the fishpond of Polgár predominate. It seems necessary that besides giving the number of individuals, we should also provide data on the biomass of phytotectonic organisms and their production. This requires a great degree of professional knowledge, it is true, but it is indispensable with an accurate exploration of the situation. By analysing the results of our investigations, even though only is general outlines, it seems that, owing to the dominance of the green algae, the biomass of the organisms is—in comparison with the number of individuals of greater value in the oligotrophic water of the pond at Nyékládháza than in that of the three other ponds. Although we have inadequate experimental data, the predominance of green algae in the oligotrophic water may be explained by the lower level of competition by the planktonic organisms in the "struggle" for nutrients, light and other factors. In waters of planktonic eutrophication, similarly to the macrophyton (OLSEN 1964; WIUM-ANDERSON

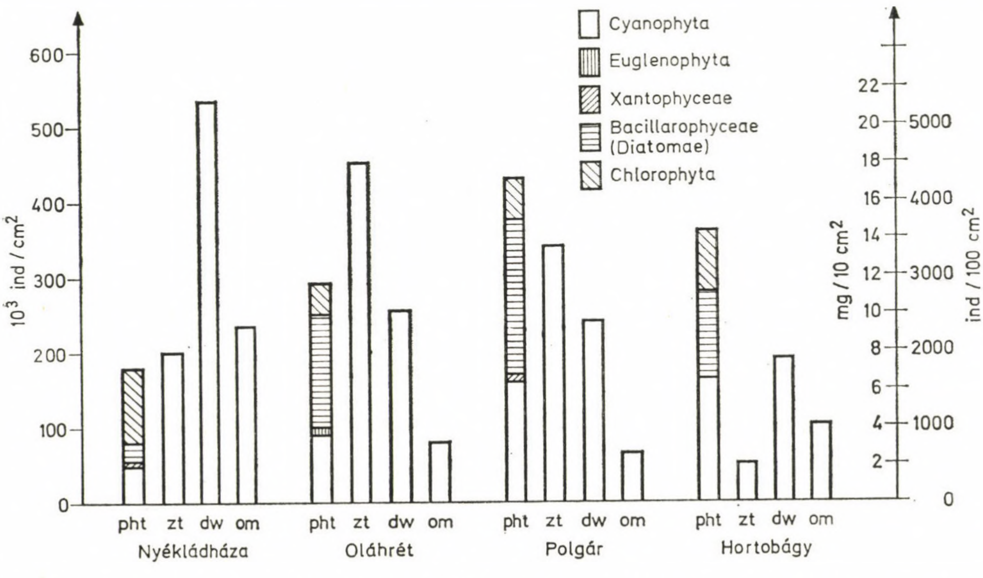

Fig. 2. The quantity and the biomass of biotecton organisms collected from the *Typha latifolia* L. tands of water bodies with different trophic state, in September, 1974

1974; etc.), the phytotecton is also reduced and concentrated only in the near-surface parts of the substrate, while in the deeper parts mainly heterotrophic organisms can be found. Parallely with the rise of the eutrophic state of the water to a certain level, the qualitative and quantitative composition of the phytotecton also changes. Indications of that state, therefore are its great production, high chlorophyll content (STROCKNER and ARMSTRONG 1971; SZCZEPANSKI 1968; etc.), changes in the degree of diversity of the community, and the seasonal dynamism's becoming irregular (HARGRAVES and WOOD 1968; PIECZYNSKA 1970), at a certain phase (in the polytrophic state), the structure of the biotecton — owing to the environmental factors' becoming unfavourable — indicates not only the trophic state but also the autosaprobity which is in organic unity with eutrophication.

Of phytotecton and zootecton, which constitute an interacting system, zootecton as an operative unity is also fealt with in the paper. *Epistyllidae* of settled life-form were found in great number in the zootecton specimens taken from the impondment of Oláhrét, similarly to the fishpond at Polgár, but here, as a result of the appearance of the predatory and parasitic *Hirudinidae* and *Crustacea*, their number was reduced. It is interesting that nematodas live in great number only in the phytotecton consisting of filamentous green and blue algae in the pond of Nyékládháza. Besides the eu-zootecton members (e.g. *Bdelloidea*, *Plumatella*; LAKATOS 1975), the mero- and xeno-biotecton organisms are also food of fish (PREJS 1970), and the changes taking place in their composition mainly in case of ponds can only be explained by the activity of fish. Between the settled phytotecton and zootecton organisms a peculiar struggle takes place for the submersed substrate, which could be experienced in the case of specimens taken from the impondment of Oláhrét.

On the basis of zootecton data of the four water bodies examined we calculated the SHANNON's species diversity values (H'), the evenness (J), and the diversity maximum (H_{max}); the results are given in Table 4. No diversity decrease known from the literature (MOSS 1973), and supposed on the basis of phytoplankton results, was experienced in the direction of oligo-trophic-

Table 4

SHANNON's *diversity (H'), evenness (J), species number (S), total number of individuals (N) and maximum diversity (H_{max}) calculated from the zootecton data of four ponds*

	H'	J	S	N	H_{max}
Nyékládháza	1.27	0.37	11	2015	3.46
Oláhrét	1.73	0.41	18	4488	4.17
Polgár	1.61	0.44	13	3454	3.70
Hortobágy	1.49	0.58	6	618	2.58

mesotrophic-eutrophic-polytrophic water bodies. On the basis of our investigations, the zootecton taken from the impondment of mezo-eutrophic trophic state at Oláhrét proved of greatest diversity. Moss (1976), in the case of species diversity calculated for epiphytal diatom algae, found that the community in the mesotrophic water body was more diverse than in the eutrophic one. On the basis of the periphyton examinations of HARGRAVES and WOOD (1968), too, the phytotecton obtained from the mesotrophic pond was the most diverse. As a basis for comparison, we now present PREJS' (1977) species diversity index values (*H*') which he calculated from the results of investigations into the benthic *Nematoda* of the littoral ponds of different trophic state. These values also support those mentioned above:

Lake	Trophity	Littoral	
		shallow	deep
Mikolajskie	eutrophic	2.3	2.4
Zarnowickie	mesotrophic	—	2.8
Char	oligotrophic	2.7	2.4

Our experimental results can be well compared with those of PIECZINSKI (1977), since the Polish author also obtained the greatest species number and number of individuals for macroperiphyton (= macrozootecton) in the mesotrophic lake Taltowisko.

In Table 5, the number of the common and the particular phytotecton species is presented (in relation to one pair of ponds only). The results are similar to the SÖRENSEN's similarity index values (Table 6) calculated from the phytotecton data of the four lakes, and to the diversity results of the zootecton species, and thus show:

a) the pair of ponds in Oláhrét and Polgár (great diversity), and
b) the pair of ponds in Nyékládháza and Hortobágy (small diversity).

Moreover among the individual pairs the greatest number of common species and the smallest number of particular species can be noticed. PREJS (1977) states in his paper that the similarity coefficient is especially different

Table 5

Number of common and particular phytotecton species in the lakes examined, in pairs

	Ny	O	Ny	P	Ny	H	O	P	O	H	P	H
Particular	14	24	13	9	11	10	18	4	22	11	10	13
Common	4		5		7		10		6		4	

between the mesotrophic and the eu-polytrophic lakes and that species diversity decreases from the mesotrophic bodies to the polytrophic ones. CHEKANOWSKI's similarity indices have been calculated from the phytotecton's frequency data of three degrees and from the zootecton's frequency data (Tables 7 and 8), and the same similarity dentrogram was obtained for clusters calculated from SÖRENSEN's index as for clusters made on the basis of the former indices with WPGM fusion (Figs 3, 4 and 5). The values of the cluster made from the CHEKANOWSKI indices with the WPGM method, and with the use of the transformed physico-chemical parameters measured in the lakes which are most characteristic of trophic state — as well as the values of the dendrogram thus compiled (Fig. 6) are different from the previous values. We

Table 6

The semi-matrix of the SÖRENSEN*'s similarity indices calculated from the phytotecton data of the four ponds*

	Nyékládháza	Oláhrét	Polgár	Hortobágy
Nyékládháza	1.0000	0.2105	0.4545	0.6667
Oláhrét		1.0000	0.9091	0.3636
Polgár			1.0000	0.3077
Hortobágy				1.0000

Table 7

CZEKANOWSKI*'s similarity indices calculated from the frequency data of three grades of the phytotecton*

	Ny	O	P	H
Nyékládháza	1.0000	0.1250	0.2727	0.4091
Oláhrét		1.0000	0.4918	0.2258
Polgár			1.0000	0.2857
Hortobágy				1.0000

Table 8

CZEKANOWSKI*'s similarity indices calculated from the frequency data of the zootecton*

	Ny	O	P	H
Nyékládháza	1.0000	0.3904	0.4147	0.1768
Oláhrét		1.0000	0.2210	0.2354
Polgár			1.0000	0.6298
Hortobágy				1.0000

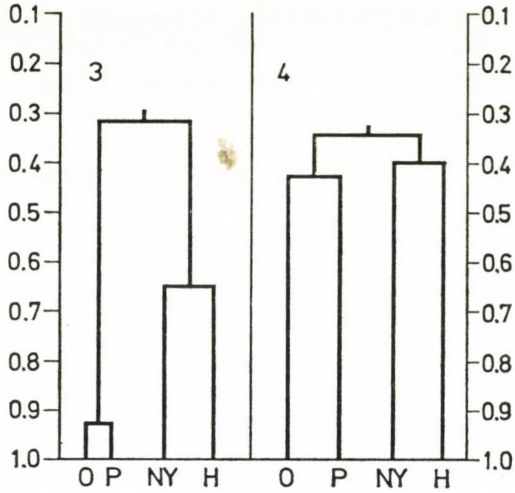

Fig. 3. Cluster compiled from SÖRENSEN's indices, with WPGM method, on the basis of the presence or absence of phytotecton (Table 6)
Fig. 4. Cluster compiled on the basis of CZEKANOWSKI's indices, with WPGM fusion, form the quantitative data of three grades of the algal biotecton (Table 7)

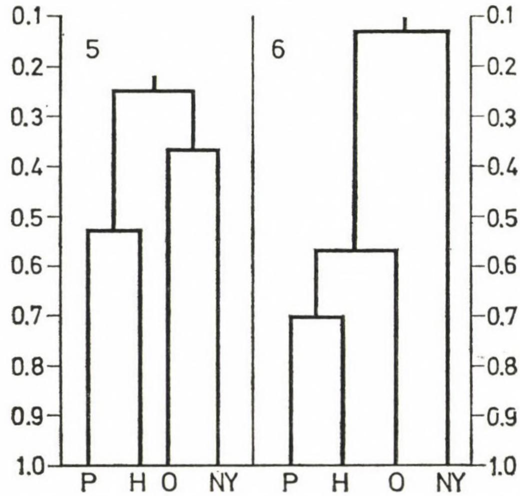

Fig. 5. Cluster compiled on the basis of CZEKANOWSKI's indices with WPGM fusion, from the quantitative data of zootecton calculated for individual/cm² (Table 8)
Fig. 6. Cluster calculated from CZEKANOWSKI's indices, with WPGM method, on the basis of the transformed data of physical-chemical parameters measured in the ponds (Table 9)

attempted with very great caution to find an explanation for the relationship between oligotrophic-polytrophic and (b) meso-eutrophic — eutrophic lake pairs — experienced on the basis of our biotecton examinations.

Table 9

The semi-matrix of the CZEKANOWSKI's *indices calculated from the physical-chemical parameters of the ponds*

	Ny	O	P	H
Nyékládháza	1.0000	0.1069	0.2066	0.1472
Oláhrét		1.0000	1.0000	0.6782
Polgár			1.0000	0.7053
Hortobágy				1.0000

The biological water quality indices of the water bodies (FELFÖLDY 1976) can be analysed independently of each other, correspondingly to our practical requirements. Accordingly, a list of trophic states can for example be compiled for water bodies. In the eutrophication series thus set up, however, beyond a certain threshold value of the eutrophication, the nutrient itself can have a less determining role, and as against this, the importance of other abiotic factors may increase. "*The positive relationship between estimates of primary production including standing crops of fresh water periphyton (biotecton) and water hardness is well documented*" (BROWN 1973) If the total hardness of the four lakes is given in N°, the following interesting results are obtained:

Water-body	Total hardness (N°)
Nyékládháza	14.65
Oláhrét	11.85
Polgár	10.10
Hortobágy	7.06

On the basis of the above data, and of other components of halobity, the water bodies of Oláhrét and Polgár can be considered in pair. However, the importance, the influencing role of biotical factors on the structure of the biotecton community, in addition to the chemical character of the water, cannot be left out of consideration either. This biotic effect — although it is difficult to be explored either quantitatively, or even qualitatively — can nevertheless be significant in a given case, as for example the "grazing" of the herbivora organisms of the zootecton and of the animals of other communities on the

biotecton. The host plant structure and physiological state of the substratum, and the role of other factors these effect is not satisfactorily known as yet, should also be mentioned. Therefore, it is only the further examinations that will make it possible for us to give satisfactory answers to the questions which have been raised, for this phenomenon is inexplicable on the present evidence.

In spite of the difficulties mentioned above, it can be inferred that the composition of the biotecton collected from the natural substrate is related to the trophic state of the given water body, and it is the most diverse in water bodies of meso-eutrophic state. In the case of oligotrophic water bodies, the large phytotecton biomass and the community of low diversity are characteristic. Great similarity has been found between the qualitative compositions of the biotecton specimens taken from oligotrophic water bodies and from polytrophic ones. However, in our opinion, in the latter case autosaprobity also plays a part. Further refinements in the biotecton analysis, will enable us to use it for satisfactory detections of changes of smaller extent, too, since its results contain — in a condensed form — the events of the past and the precursors of the ensuing changes.

Summary

The hydrobiological examination of aquatic ecosystems can no longer be restricted to mere plankton analyses. We have to extend our work, especially in the case of shallow lakes and water impondments, to the study of the benthonical complex, that is benthos and biotecton, as well.

The results of the comparative analyses into the taxonomy and biomass of the biotecton specimens collected in the autumn of 1974 from the natural substratum (*Typha latifolia* L.) water bodies of different trophic state (the pond of Nyékládháza: oligotrophic; the impondment of Oláhrét: meso-eutrophic; the pond of Polgár: eutrophic, and the pond of Hortobágy: polytrophic), are in a positive relationship with the eutrophication of the water bodies examined.

It has been inferred that at a certain phase of the succession process of eutrophication the structure of biotecton — owing to the environmental factors' becoming unfavourable for it — indicates not only trophity but also autosaprobity constituting an organic unity with eutrophication.

Through the analytical results, in our present paper, we intended to touch on the prospects lying in the controlling role of biotecton in the quality of water. Naturally, if we want to go further, the study of many unanswered questions is necessary.

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ADDITIONAL CONTRIBUTIONS TO THE KNOWLEDGE OF THE MELOCACTUS SPECIES OF CUBA

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The author published in the volume 22 (1—2) of this periodical (1976) a monographic study of the Cuban *Melocactus* species enclosing the descriptions of some new taxa. Simultaneously A. ARECES also described two new *Melocactus* species from Cuba (*M. actinacanthus* and *M. holguinensis*) one of them proved to be identical with *M. jakusii* Mészáros. This paper gives a new ranging for all the published Cuban *Melocactus* taxa and a new complete analytical key for them.

Introduction

The study of the Cuban *Cacti* has been getting under way during the last decade. About 40 years after the research activity of LEÓN it is a Cuban specialist again, — ALBERTO E. ARECES MALLEA — who has carried on studying the *Cactus*-flora of Cuba. As a result of his work two *Melocactus* species were described new to science (ARECES 1976a, b).

During my two year sojourn in Cuba (1973—1975) I tried to make a collection of *Melocacti* as complete as possible and to have a thorough knowledge of them. After my turning to Hungary summarized the results in a monographic study and described some new taxa (MÉSZÁROS 1976). Since at the time of my further publication the results of ARECES were not known this paper will give an utmost complete review of the Cuban *Melocacti* for the time being.

Results and discussion

1. *Melocactus actinacanthus Areces 1976*

(Ciencias Serie 10. Botánica Univ. Habana No. 9: 4.) This new species lives on serpentine rocks in the Sierra de Agabama near to the Rio Agabama (Las Villas Province). It was discovered by ARECES and E. DEL-RISCO. The type specimen was collected in March 1974, and deposited in the University Herbarium of Habana (HABJ). Description is after that of ARECES as follows:

Plants of small, flattened globose stature, not ramifying, with 8—9 ribs. Mature individuals of 9—13.5 cm height and 10.5—14.5 cm diameter. Ribs 1.7—5 cm wide, straight, vertically decurrent, protruding in 1—2.5 cm. Areoles ovate of a 1—2.2 cm long distance between them; 7—9 areoles per ribs. Bristles 5—6 per areoles, young ones purplish at the apex of the stem, older ones blackish-purple, later grayish-white or yellow, apically slightly darker. Central bristle absent, the radial ones curving towards the body; the uppermost one shortest, 0.8—1.7 cm long, the 4 lateral ones 1.5—2.2 cm, the lowermost one slightly longer, 1.7—2.4 cm long. Cephalium depressed, diameter 5.5—6.5 cm, maximal height 3 cm, covered by white and dense lanuginous hairs and 1.5—2 cm long, reddish bristles. Flower purplish, tubulate, 1.3—1.5 cm long and 0.4—0.5 cm wide. Fruit thin, oblong-obovate, 1—1.5 cm long and 0.4—0.7 cm thick, pale pink at the upper third, whitish at the base. Seeds shiny black, 1 mm of diameter.

Melocactus actinacanthus Areces is close related to *Melocactus matanzanus* described by LEÓN at 1934. Both are belonging to the Serie *Matanzanus*.

2. *Melocactus holguinensis Areces 1976*

(Ciencias Serie 10. Botánica Univ. Habana, No. 10: 3.) This species had been discovered originally by the Hungarian geologist P. JAKUS in 1973. It was he, who called my attention and led me to the classic locality of the species. The first authentic specimen was collected by P. JAKUS and me in March of 1975. I recognized this species had to be considered as new to science and named it after its discoverer *Melocactus jakusii*. I had described it as sson as the summer of 1975 and presented to the Acta Botanica Acad. Sci. Hung. in the November, same year. ARECES did not know this species in January, 1976 either, nor its locality, but he was told, my description had been being in press. Later he got to obtain information of the type locality of *Melocactus jakusii*, visited it in February, 1976 and collected specimens describing them by the name of *Melocactus holguinensis*. Since the issue of a manuscript multiplied by phototyping took shorter time than that of a printed semiannual periodical, the description of *M. holguinensis* had been published as soon as April, 1976, while that of *M. jakusii* was issued in the volume 1976 of this periodical

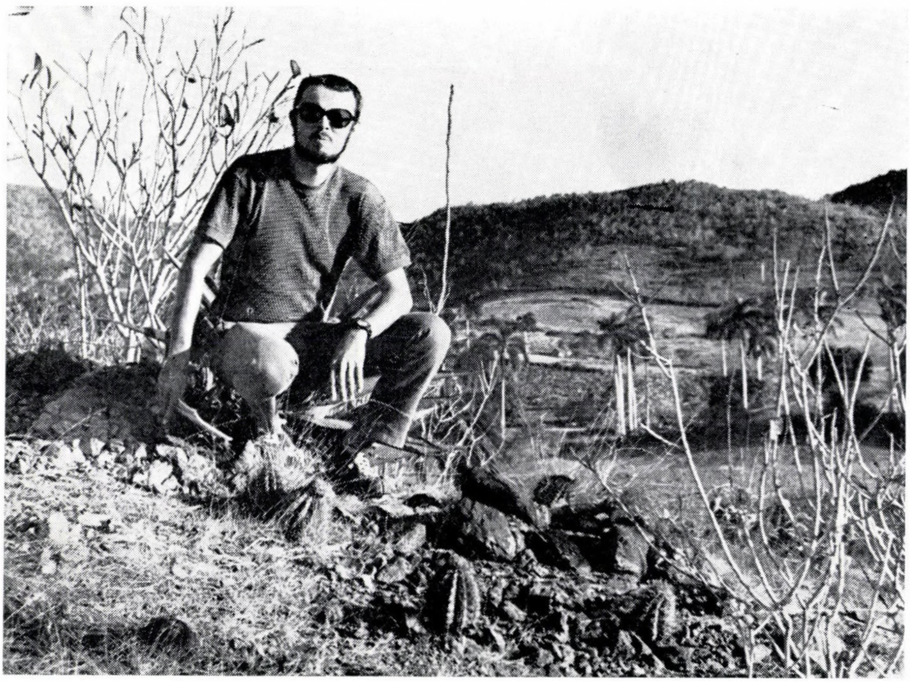

Fig. 1. Type locality of *Melocactus holguinensis* Areces in the NW slopes of the Mt. Cerro Galano, with Mr. P. JAKUS, discoverer of this species. Photo by Z. MÉSZÁROS in March, 1975

Fig. 2. Melocactus holguinensis Areces (Syn.: *M. jakusii* Mészáros) at the type locality. Photo: Z. MÉSZÁROS

— after suffering a considerable delay — as late as February, 1977. So *Melocactus jakusii* — although it was described earlier — must be considered as a synonymon.

3. *Review of the Melocactus species of Cuba*

Considering the recently described taxa, the *Melocactus* species of Cuba can be listed as follows:

Series Matanzanus Mészáros ser. nov.

Plantae depressae vel semiglobosae, verticaliter compressae, altitudine (sine cephalio) latitudinis minores, non ramificatae. Costae 5—9; spinae areolarum vicinarum remotae inter sese non tangentes, corpus versus curvatae, corpus plantae inter spinas bene conspicuum.

Species typica: *Melocactus matanzanus* León

1.a. *Melocactus matanzanus* León 1934

1.b. *Melocactus actinacanthus* Areces 1976

Series Guitartii Mészáros ser. nov.

Plantae depressae vel globosae, altitudine (sine cephalio) latitudinis minores vel aequilongae, non ramificatae. Costae 11—13, spinae dense dispositae, eae areolarum vicinarum tangentes, radiales corpus versus recurvatae, centrales ± elatae.

Species typica: *Melocactus guitartii* León

2. *Melocactus guitartii* León 1934
3. *Melocactus holguinensis* Areces 1976
   (*M. jakusii* Mészáros 1976)

Series Harlowii Mészáros ser. nov.

Plantae ellipticae vel columnares, altitudine (sine cephalio) latitudinem superantes, maturae frequenter ramificatae Spinae variae, eae areolarum vicinarum tangentes, radiales centralesque plerumque similes, radiales non vel rarissime recurvatae.

Species typica: *Melocactus harlowii* (Britton et Rose) Vaupel

4. *Melocactus harlowii* agg.
4.a. *Melocactus harlowii* (Britt. et Rose) Vaupel 1912
4.b. *Melocactus borhidii* Mészáros 1976
4.c. *Melocactus evae* Mészáros 1976
5. *Melocactus radoczii* Mészáros 1976
6. *Melocactus acunai* León 1934
   — ssp. *acunai*
   — — var. *flavispinus* Mészáros 1976
   — — var. *acunai*
   — ssp. *lagunaënsis* Mészáros 1976
7. *Melocactus nagyii* Mészáros 1976

4. Identification key to the Melocactus taxa of Cuba

Taking into consideration the recently discovered new taxa, the identification key of the Cuban *Melocacti* is to be amplified as follows:

Key to the series:

1 a Plants of small or medium size, flattened globulose to semiglobose, or their height not much differing from their diameter; not ramifying. Radial and central bristles readily distinguishable; radial ones curving towards body, central ones — if they exist — protruding or curving towards body 2

b Plants of various sizes, more or less elongated or columellar, their height (without cephalium) always greater than their diameter. Mature individuals rather inclined to ramification (with different frequency in the various species). Radial and central bristles hardly distinguishable, radial ones not or hardly curving towards body .....**Series Harlowii**

2 a Ribs less than 10, all bristles bending towards body, those of the next areoles not meeting, body apparently conspicuous among the bristles ....**Series Matanzanus**

b Ribs more than 10, bristles of the next areoles meeting, radial ones slightly bending towards body, central ones straight protruding, their length more than 2 cm **Series Guitartii**

Key to the species of the Series Matanzanus:

1 a Diameter of mature plants less than 10 cm, bristles 7—9 per areoles, central bristle present .... **M. matanzanus** León
b Diameter of mature plants more than 10 cm; bristles 5—6 per areoles, central bristle absent .... **M. actinacanthus** Areces . . .

Key to the species of the Series Guitartii:

1 a Flattened globose plants, height less (without cephalium) than its diameter. Bristles densely placed; the two strong central bristles exceeding 3 cm .... **M. guitartii** León
b Globose or slightly ovate plants, broadest in their lower third or next to the base; height identical with diameter or slightly higher (without cephalium). Bristles seem to be sparser, one or two central bristles generally 2—2.5 or at most 3 cm long .. **M. holguinensis** Areces

Key to the species of the Series Harlowii:

1 a Bristles extremely strong and thick, central ones exceeding 4 cm, and more than 3 mm thick at the base. Stature large, columellar, often ramifying, branches oblong. A varying species, rich in local forms .... **M. acunai** León
— Cephalium bristles rigid, regularly arranged, fruit oblong-obovate ...... ssp. **acunai**
— — Bristles brown .... var. **acunai**
— — Bristles honey-coloured, occasionally brownish at the base var. **flavispinus** Mészáros
— Cephalium bristles soft, irregularly arranged, fruit short, widely obovate ssp. **lagunaènsis** Mészáros
b Bristles thinner, if subuliform their length not reaching 4 cm, not thicker than 3 mm at the bsse; branches mostly globose 2
2 a Bristles rigid, not elastic. Cephalium higher than wide; cephalium bristles loose, soft, more or less irregularly disposed, dull. Columellar plants of large stature, sometimes ramifying. A varying species, rich in local forms .... **M. nagyii** Mészáros
b Bristles thinner, more or less elastic. Cephalium discoid, height smaller than wide (exceptionally that of old individuals elongated). Cephalium-bristles hard, strong, erect, regularly arranged and generally of vivid colouration 3
3 a Stature large, globose or oblong-ovate (diameter 12—16 cm, height 11—18 cm without cephalium .... **M. harlowii** (Britt. et Rose) Vaupel
— Fruit deep pinkish purple .... f. **harlowii**
— Fruit white .... f. **candida** Mészáros
b Stature smaller in diameter (in fully grown state), generally less than 10 cm, exceptionally 10—12 cm 4
4 a Slender, columellar plants, diameter of fully grown individuals not exceeding 6—8 cm, height at least twice greater; mature plant with 5—8 strikingly lanuginose areolar rows below cephalium. Flowers small, 7—9 mm wide .... **M. borhidii** Mészáros
b Stature smaller, oblong-ovate, diameter 8—10—(12) cm, height always greater than diameter but not one and a half or twice higher. Areolar rows below cephalium hardly lanuginous. Flowers larger 5
5 a Body densely ribbed (13 ribbs). Central bristles straight or slightly upcurving. Cephalium-bristles dull brown, sparsely spaced, diameter of full blown flowers greater than 20 mm **M. evae** Mészáros
b Body sparsely ribbed (10 ribbs). Central bristles definitely upcurving. Cephalium-bristles bright, rufous, densely disposed. Diameter of full blown flowers 12—14 mm or less **M. radoczii** Mészáros

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EXPERIMENTAL ANALYSIS OF THE CONNECTION BETWEEN LEAF GROWTH AND INSECT CONSUMPTION*

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An experimental model analysis of insect consumption in foliage was carried out.

With the growth of the damaged leaf also the area of the holes increases. As the growth rate of in the various spots of the leaf blade is not identical, the holes which are initially of identical areas also become have different areas and often different shapes as well. On this basis, the species examined can be classified into three types (apical, basal and medial) and two subtypes (abaxial, axial) of growth.

The injuries caused by leaf-consuming insects continually expand and thus along with the increase in the average weight falling to a unit of leaf area during the growth time, the indirect damage becomes considerably greater than the quantity of organic matter actually consumed by the insect. For the approximation of the actual damage, an ordinary mathematical correlation was applied on the basis of the close correlation between the growth indices.

Introduction

Heterotrophs regularly consuming the leaves of forest plants can influence the changes in yearly foliage production considerably. In the sampling area of oakwood forest at Sikfőkút (JAKUCS 1973) the yearly loss in assimilating surfaces coming mainly from worm-eating fluctuates between 15—40%, but the maximum reached even as high as 54% in the case of the dominant tree of the forest, *Quercus petraea*, in 1975 (JAKUCS and VIRÁGH 1975; VIRÁGH 1977). The forest being in a dynamic stability, the organic matter waste was always supplemented within a short time by new shoots, and thus the autotrophic production balance of the forest became restored during the vegetation period.

Leaves consumed to different extents were also left on the trees. The growth of these leaves was investigated with experimental methods. Similar examinations were carried out in an American *Liriodendron tulipifera* forest by REICHLE et al. (1973), too.

In the forest of the Sikfőkút Project the foliage-consuming organisms are mainly the still young, strongly growing leaves. Those leaves which were consumed up to the main rib died away shortly, those however which were damaged to a smaller or greater extent continued growing (Fig. 1). Therefore, we wished to get answers to the following main questions:

1. Does the size of the hole made by the folio-trophic organisms change parallel with the leaf growth?

2. If it does,

— to what extent?

— for how long?

— is there any connection between the growth rate of the leaf area and that of the hole?

— to what extent is the former connection suitable for estimation of the initial state?

— what kind of a connection exists between the quantity of leaves consumed by the leaf-eaters and that of the organic matter waste measured or estimated afterwards? In other words, what is the quantity of actual consumption and how much does the organic matter waste of the plant originate from that consumption?

* Sikfőkút Project, No. 38.

Fig. 1. Leaves consumed to different extents

3. What extent of damage is endurable for the leaf during the growth phase, or what extent of damage can cause its destruction?

The method of examination

We were led by the aim to carry out with quick and simple methods the modelling of consumption damages and their consequencies in the living and growing leaves.

The leaves of trees and shrubs selected were marked with numbers pressed on rotex-ribbons and fixed to the branches. The activities of insects consuming the middle of the leaf blade were modelled by punching with sharpened metal tubes of 2 mm diam. in smaller leaves and of 3 mm diam. in larger leaves. For modelling the damage caused by insects consuming the edges of leaf blades, leaf pieces of different sizes were cut down.

For an unbroken recording of the changes, a new method was applied. Using sunlight (or, in very clouded weather, artificial light) contact copies were taken of the living leaves on photocopying paper marked "Diazol S". The light sensitivity of the photocopying paper is relatively low. The person carrying out the investigation can prepare it for exposition by keeping it in his own shade. The Diazol-paper is put underneath the leaf, then a glass plate is put on the leaf and exposed to light. The yellow-colour diazonium-salt decomposes in about 10—15 seconds in the areas reached by light and thus the positive sciagram picture is recorded. (In little light exposing to light for even 1—1.5 minutes may be necessary.) The exposed diazol-paper was then fixed in the vapour of saturated NH_4OH, in a darkened desiccator. In this way, the picture of the leaf blade became recorded in blue colour on a white basis.

This method gives the leaf contours, the rib course becomes visible only in the case of thin leaves. It is to be noted that only dry leaves are suitable for photocopying since water dissolves the diazonium salt from the photocopying paper. Imperfection can occur if the leaf blade cracks when it is punched, or if it creases, moves away or tears while photocopying is made.

The investigations were carried out in 3 series:

1. One hole was punched in one leaf blade.
2. Several holes were punched in one leaf blade.
3. The leaves were pruned to different extents (by removing 25%, 50% or 75% of the leaf blades).

Photocopying times were different in the individual species; on the average, they followed a sequence of 3—4 or 7—10 days (see Table 1).

In choosing the species examined, we were led also by the viewpoint that information should be obtained on the most important forest-forming trees and shrubs and in this way what generalizations on the experimental results can be made. We paid attention to the leaf growth of a total of 29 species. There were 21 tree and shrub specimens and 8 herb specimens. Most of the data were provided by the following species:

— *Acer tataricum* L.
— *Quercus robur* L.
— *Quercus cerris* L.
— *Tilia argentea* Desf.
— *Quercus rubra* L.
— *Platanus hybrida* Brot.
— *Catalpa bignonioides* Walt.

The latter 3 species are not indigenous in Hungary, but their leaves grow quickly and are large, thus the changes are well observable on them. In 1977, the growth of more than 800 leaves was examined.

The investigations of light and shade-adapted leaves of plants were not separated. The comparison of these has already been carried out in a separate study (JAKUCS and VIRÁGH 1975). Since our aim was to observe the growth ratios within one leaf, the numerical values were not influenced by the differences coming from the horizontal and vertical adjustement of the leaves.

Processing of the photocopy data

The photocopies of the individual leaves were processed in collection. The following data were measured in all copies:

— leaf area (LA, mm²)
— leaf length (LL, mm)
— leaf width (LW, mm)
— hole area (HA, mm²)
— location of the hole in the leaf blade (mm; percentage of the full length of the leaf calculated from the leaf base)
— distance of the centre of the holes from the leaf base, measured from one another and the apex (mm)
— distortion of the shapes of the holes.

The size of the leaf area was measured with a mm²-mesh (EVANS 1972). The determination of the hole area in the case of holes greater than 25 mm² was carried out with a 1 mm² accuracy. In case of holes smaller than 25 mm² we measured the diameters under preparatory microscope, at a magnification of 8 × and 16 ×, with an accuracy of 0.1 mm and the area was calculated from them.

The evaluation would have been complicated with the actual values measured, therefore dynamic relative numbers of a constant basis were formed from them (KÖVES and PÁRNICZKY 1975), which were named growth indices. Their symbol is GI. The constant basis of comparison is the data series obtained at the time of the first photocopying (T_0); dividing be this the data series of the later photocopying (T_i), we received easily feasible and well comparable measurement results. For example, the area of an oak leaf (LA) was 320 mm² at the first measurement, and 3720 mm² at the last measurement; thus, the growth index of the leaf area (GI_{LA}) = 3720 : 320 = 11.62. The growth index shows how many times greater an individual measure of the leaf is in the period of investigation.

In the basic tables, the following data are given, besides the preceding data (or in place of them):

— growth index of the leaf area, GI_{LA}
— growth index of the hole area, GI_{HA}
— growth index of the leaf width, GI_{LW}
— growth index of the leaf length, GI_{LL}
— growth index of the hole distances, GI_{HD}
— product of multiplying the leaf length values by the width values
— square of the indices of area increase
— product of multiplying the indices of area increase in leaf and hole.

Method of evaluating the results

To prove what kind and strength of correlation exists between the increase in leaf area and of hole area, the growth indices were compared with one another by means of two-variable regression analyses. In the course of this, the parameters of the functions and the regression equations were determined (CHAPMAN 1976; KERSHAW 1973). The regression calculations were mainly carried out by reducing the values into series of element numbers $n = 10$; $n = 20$ and $n = 40$. Then by means of variance analyses we determined probability level at which the correlation between the variables proves to be significant (SVÁB 1973; EZEKIEL and FOX 1970).

In leaves with multiple holes we examined also the growth characteristics of leaf widths and lengths. The leaf widths were measured at definite, well-identifiable points (5—7 measures on a leaf), then by starting from the base towards the peak, we measured the distances between the individual holes. On the basis of the results of these two measure-series, the growth types of leaves were determined.

Results

Growth of leaves punched at one point

The leaves of six plant species 50 pieces each were punched with a sharp metal tube of 3 mm diameter. Punching was in general, carried out on 2—5 different pieces within one species, in randomly chosen leaves, in the first week of May when the first photocopies were also prepared. At the next measuring we stated that at the time of punching the leaves of *Acer campestre*, *Crataegus monogyna* and *Ligustrum vulgare* had already completed their growth to a large extent, and therefore we give now the data of only 3 species.

In Table 1 data of minimal and maximal values of leaf and hole growth indices of the individual species (columns 4 and 5) are presented. The determination coefficients calculated in the course of regression analyses show the correlations in increases in the leaf and hole area (column 6). The results of variance calculations are given in column 7.

Quercus robur L.

The area increase indices of leaves and holes punched in the centre of the leaf show a remarkable agreement. In leaves punched in the lower third, the index of the hole increase in comparison with that of the area increase is smaller, while in these punched in the upper third it was larger. When examining the hole location at the time of second measuring of the same leaves we could see that the hole (considering the full length of the leaf) moved from its initial place 5—8% downwards. Both of these phenomena can be explained only by the more powerful growth of the upper third of the leaf.

If we draw the contour pictures taken in the individual growth phases of a leaf one on the other, the identical points of the aging leaf can be connected by a straight line. These lines intercept at one point (or in a relatively small area), which is general in the vicinity of the lower third of the leaf. Outward from this point, the uneven growth of the leaf can be observed well: the growth in width and length of the apical part considerably surpasses that of the basal part (Fig. 2).

If the growth index of the leaf is taken as an independent variable (X), and that of the hole as a dependent variable (Y), and the data are demonstrated in a coordinate system, the linear correlation between the two variables is well observable (Fig. 3a).

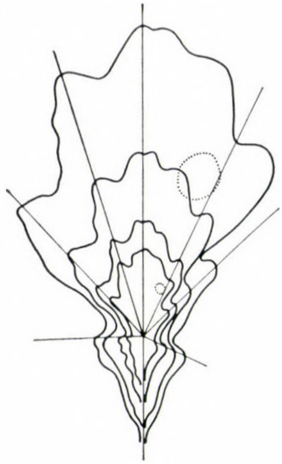

Fig. 2. Increase in the area of an oak-tree leaf, at 4 phases of its growth (from inside towards outside: state on 10 V, 13 V, and 6 VI), with the main growth directions. The dotted area indicates the initial hole and the place and size of the extended hole

Quercus cerris L.

The growth indices are very low, which is an indication that we could observe only the second phase of the leaf growth; While in punching at about the centre of the leaf area $GI_{LA} = 1.88$; $GI_{HA} = 1.72$ in general — that is the difference is very small — in punching in the lower third of the leaves, the two averages are 2.36 and 1.77, namely, as a result of the reduced growth of the lower third of the leaf the growth rate of the hole is substantially smaller.

The fact that the punching took place in the lower third of half of the leaves brought the result that the correlation rate is smaller between the two variables, the curve of the regression line is flatter and the confidence limits are wider than those in the preceding species (Fig. 3b).

Acer tataricum L.

The examinations were carried out in two repetitions and, for the regression analyses, in each case 20 pieces were chosen from the measured leaves. The determination coefficients are high, the coefficient bands are narrow (Figs 3c and 3d).

In comparison with oak leaves, the leaf growth here is evener, which is also indicated by the drawing made of the growth phases of one of the leaves (Fig. 4).

The experiments carried out in the three tree species proved that the holes made by insects' feeding become larger as a consequence of leaf growth. We have also obtained proof of the leaf growth being not even. Certain parts of the leaves grow at smaller intensity rates while other parts at a higher one, thus the increase in the injuries caused at various places of the leaf can also be of different extent.

The growth of leaves holed at several points

Punching at randomly chosen places could not possibly furnish satisfactory information on the general regularities of hole and leaf growths. Therefore, such examinations were also arranged where more than one hole (2—50 holes) was cut in each leaf, in agreement with the size of the young leaf.

Holings were in general carried out along the main ribs and subsidiary ribs. No newer holes were cut in the leaves at later periods.

The index of hole increase was determined on the basis of the mean values of the individual hole areas. Besides, a comparison was made between the individual hole sizes and leaf areas and between the increases in distances between the holes themselves and between holes and leaf edges. Part of the basic data is given in Table 1.

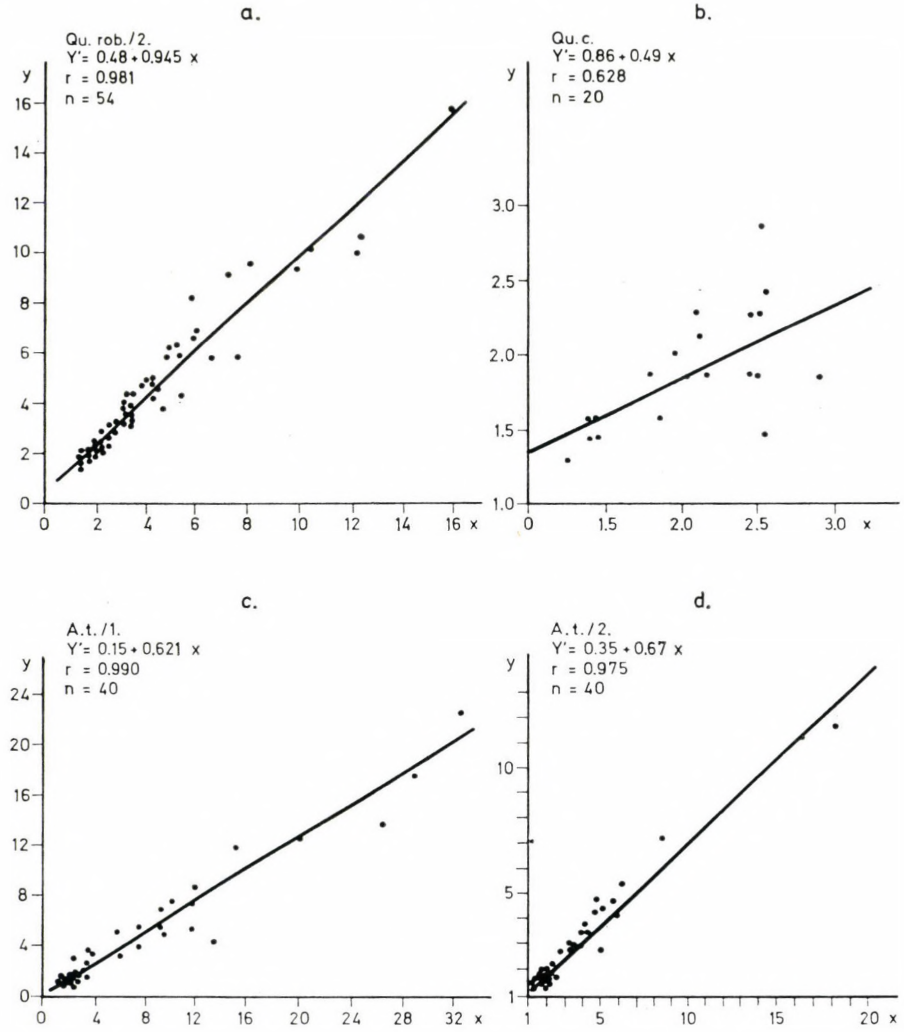

Fig. 3. **Connection between the leaf area (x) and the hole area (y). a) *Quercus robur*, b) *Quercus cerris*, c-d) *Acer tataricum***

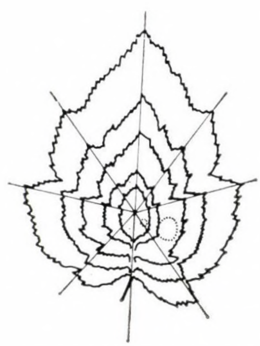

Fig. 4. Increase in the area of an *Acer tataricum* leaf, at 5 phases of its growth (12, 15, 22, 27 V and 14 VI), with the growth directions. Dotted areas indicate holes

Table 1

End values of the leaf area and growth indices in the important tree species examined, and the results of the regression analysis and variance calculated

1	2	3	4	5	6		7
Plant species	Leaf size at the time of holing, min.-max., mm^2	Developed leaf size min.-max., mm^2	End values of leaf growth indices	End values of the indices of hole increases	Mean values of determination coefficients; significance level, P%		Time of measuring
Acer tataricum	50—800	640—3 800	1.19—32.80	1.14—22.28	0.965;	0.1%	12, 15, 22 V, 14 VI
Catalpa bignonioides	200—1540	13 020—51 390	12.75—204.85	13.61—182.99	0.997;	0.1%	13, 16, 20 VI, 12, 30 VII
Platanus hybrida	640—4040	13 620—22 010	3.92—22.85	4.94—21.19	0.935;	0.1%	8, 14, 20 VI, 20 VII
Quercus cerris	230—990	590—1 670	1.25—2.90	1.28—2.85	0.395;	1.0%	6, 13, 23 V
Quercus robur	175—1610	530—5 020	1.52—15.94	1.57—15.71	0.972;	0.1%	4, 11, 16, 29 V, 17 VI
Quercus rubra	300—3180	3 420—20 270	2.33—31.46	2.42—32.66	0.862;	0.1%	13, 16, 20, 28 VI, 25 VII
Tilia argentina	115—5310	6 770—38 480	4.20—117.62	8.62—139.16	0.958;	0.1%	13, 16, 20, 23, 28 VI, 12 VII

Table 2

Changes in the indices of length and width growth of Quercus robur leaves, starting from the leaf base towards the peak

Serial number of leaves	Indices of the increase in hole distance							Indices of the increase in the leaf width at the individual holes					
	A—1	1—2	2—3	3—4	4—5	5—6	—peak	1	2	3	4	5	6
1.	1.0	1.0	1.25	1.33	1.50	1.72	1.80	1.0	1.20	1.38	1.52	1.66	1.83
2.	1.0	1.12	1.36	1.71	1.85	2.28	2.44	1.0	1.14	1.50	1.90	2.00	2.33
3.	1.30	1.42	1.55	1.85	1.92		2.16	1.46	2.20	1.66	1.95	1.82	
4.	1.76	2.42	2.53	3.33			3.20	1.93	2.18	2.68	2.85		
5.	1.21	1.71	1.78	1.66			1.83	1.43	1.70	1.71	1.80		
6.	1.88	1.81	2.12	2.66			2.80	1.61	2.25	3.38	2.78		
7.	1.14	1.81	2.50	2.85			2.83	1.0	2.12	3.16	3.00		
8.	1.61	2.16	2.50				2.80	2.14	2.30	2.41			
9.	2.0	2.62	3.75				4.0	2.0	3.16	3.63			
10.	2.13	2.33					3.36	2.20	3.11				

A—1: distance between the leaf base and the first hole
—peak: distance between the last hole and the peak
1—6: number of holes

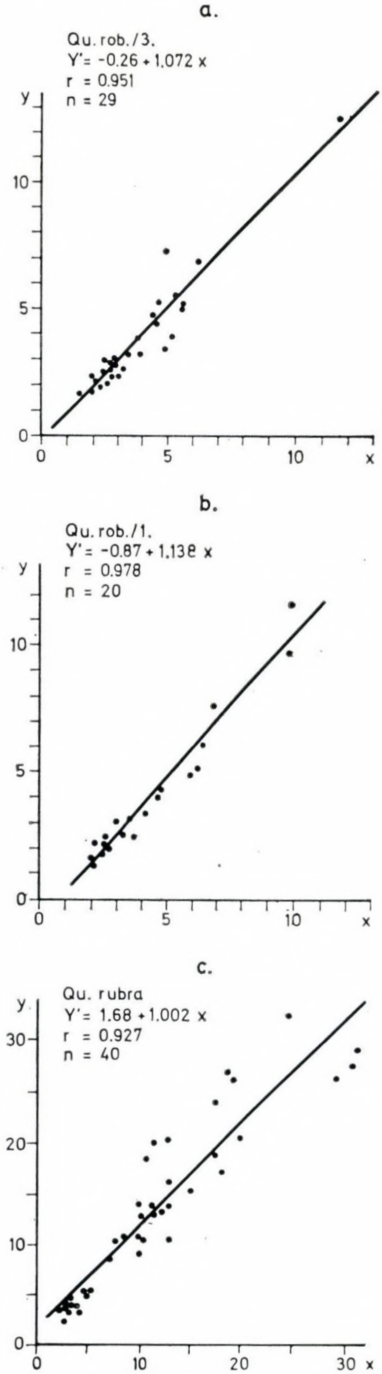

Fig. 5. Connection between increases in leaf area (x) and hole area (y). a-b) *Quercus robur*, c) *Quercus rubra*

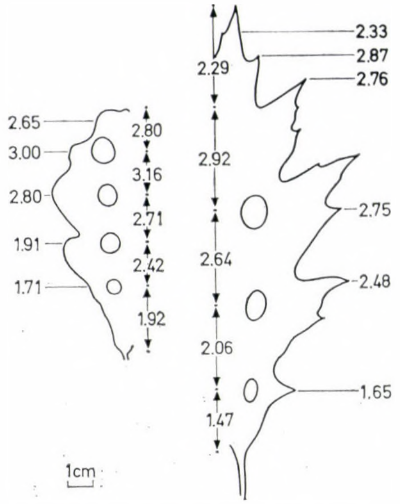

Fig. 6. Developed leaves of apical growth type in *Quercus robur* and *Quercus rubra*. The different enlarging of the holes which had been identical initially, and its close connection with the growth indices, can be observed well. The values in the central column are the indices of the increase in length of the leaf areas between the points of measurement indicated by arrows. The two extreme columns of values indicate the indices of increase in leaf widths measured in the points indicated by arrows

Quercus robur L. and *Quercus rubra* L.

Since the growth characteristics of the two oak species leaves are similar, they can be evaluated together. The calculations showed a high degree of correlation here, also between the LA and HA growths (Figs 5a, 5b, and 5c).

The hole areas increased at about the same intensity, on the whole surface of the leaf, after 2—3 days of punching. The differences in the individual holes became conspicuous after the third day, in the more intensive growth period. In the basal part of the leaf, the hole growth soon slowed down, then it stopped. In the direction of the quickly and powerfully growing peak, the size of the holes became increasingly larger, and it decreased only in the immediate vicinity of the narrowing peak (Fig. 6). This regularity is demonstrated by Table 2, in which we present the changes in the growth indices of length and width in 10 *Quercus robur* leaves, in the direction from the leaf base towards the peak.

In certain large *Quercus rubra* leaves, the holes lying alongside the secondary ribs gradually become larger while receding towards the edge of the leaf, although they do so not to such a great extent as in the direction of the peak, alongside the main rib.

Tilia argentea Desf.

The indiviuuals chosen were root shoots of strong growth which produced leaves of large surface (Fig. 7a). The growth indices of the holes are in general higher than those of area increase (Table 4). The probable reason for this is that in a large part of the leaves there were only 2—3 punching and these holes fell into the stronger-growing zone. The unexpectedly greater growth can also be caused by the dying away of the tissues at the edges of the great holes; this was observed in case of several leaves.

Although the leaf growth is relatively even, in those punched at the early phase a tendency of development contrary to that of oak leaves can definitely be detected (Fig. 8).

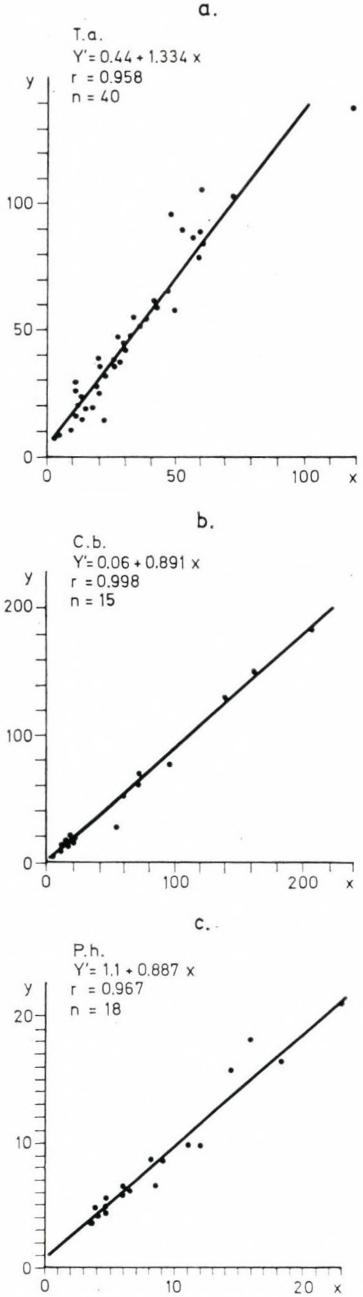

Fig. 7. Connection between increases in leaf area (x) and hole area (y). a) *Tilia argentea*, b) *Catalpa bignonioides*, c) *Platanus hybrida*

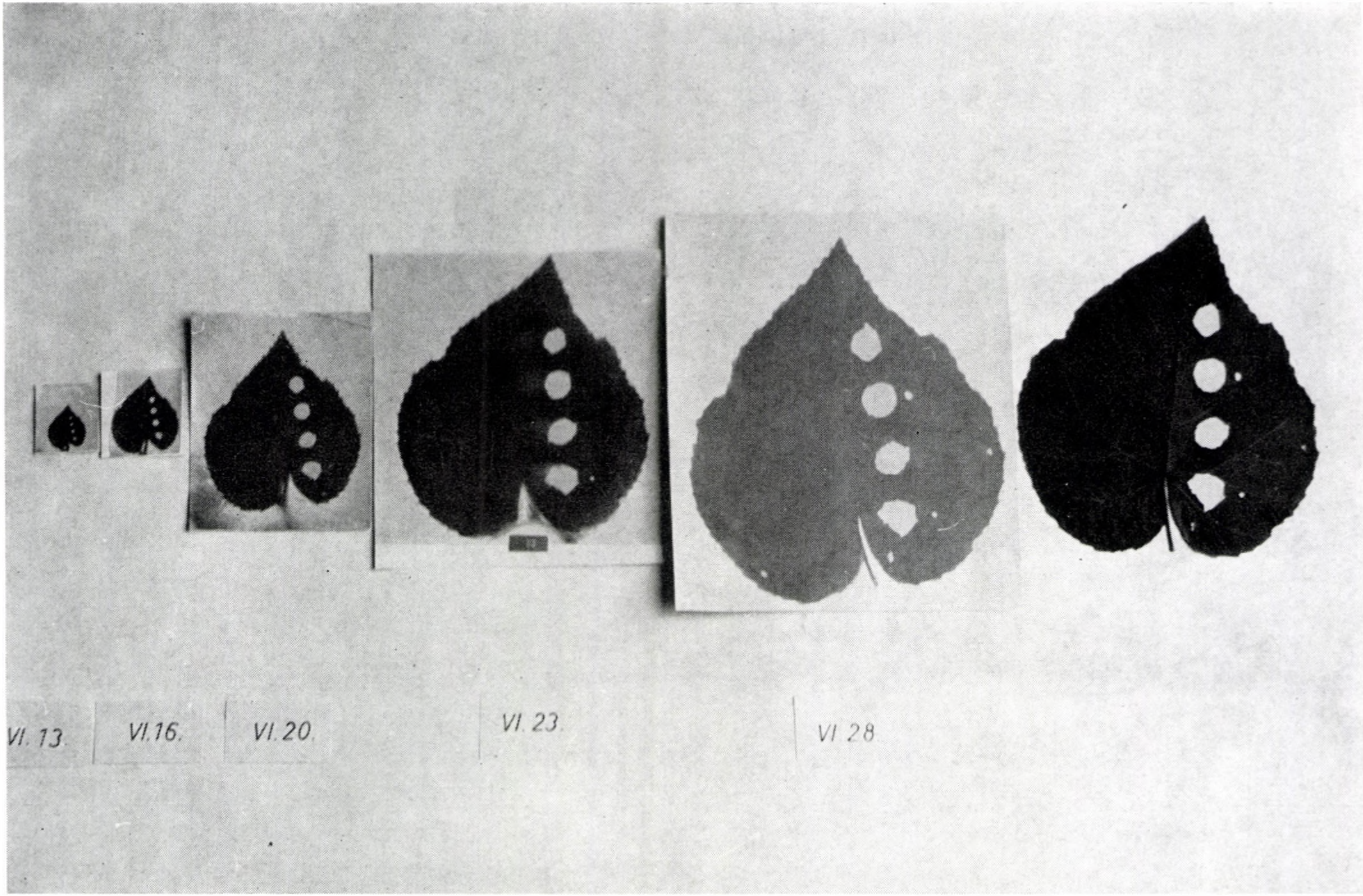

Fig. 8. Growth phases in *Tilia argentea* leaves (times of making the photocopies: 13, 16, 20, 23, 28 VI). On the right: the developed leaf (10 ×)

Catalpa bignonioides Walt.

The changes in the extremely large-growing leaves could be traced well (Fig. 7b). The growth of the leaf blade from the peak towards the base, and from the edge of the leaf towards the main rib, becomes stronger (Fig. 9). The leaf of white poplar grows in a similar way (Table 3; Fig. 10).

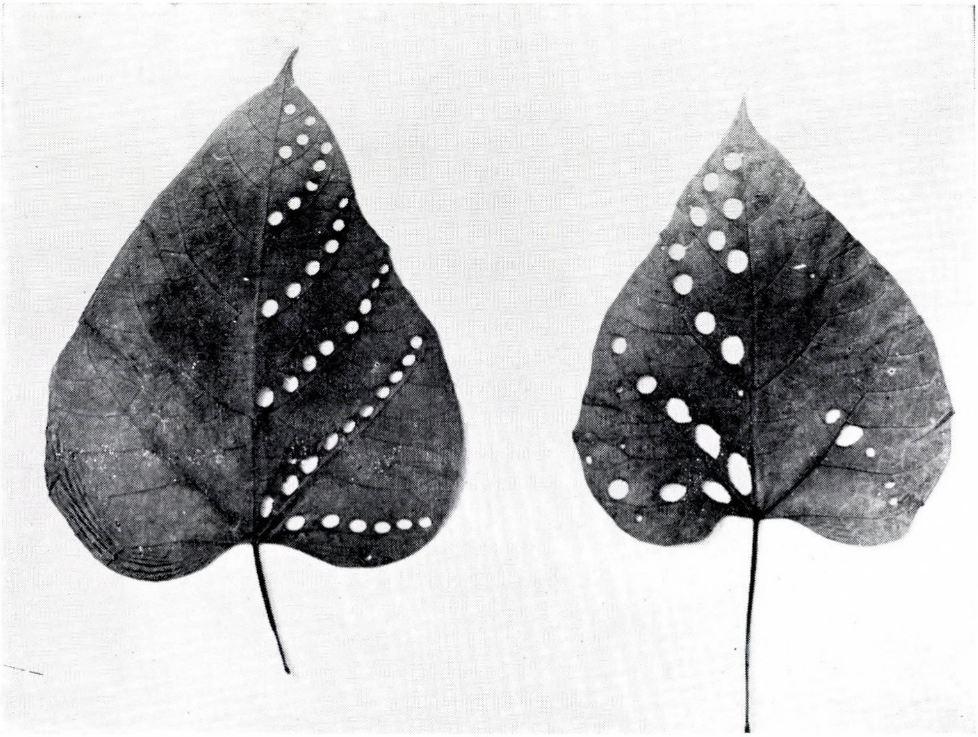

Fig. 9. Catalpa bignonioides leaf of basal-axial growth type

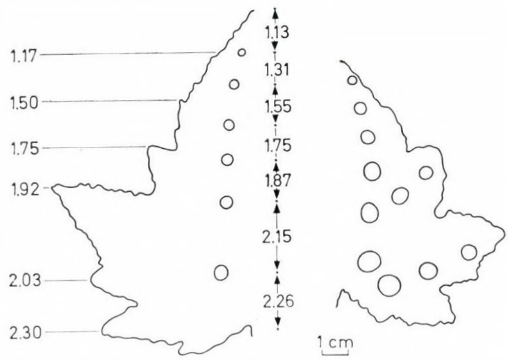

Fig. 10. Populus alba leaf growth. Left: growth indices for width; middle: for length. On the right: another leaf, grown with characteristical hole series

Table 3

Changes in the indices of increase in widths and lengths of Catalpa bignonioides (C. b.), Populus alba (P. a.) and Platanus hybrida (P. h.) leaves

Species	Indices of the increase in hole distances									Indices of the increase in widths						
	A—1	1—2	2—3	3—4	4—5	5—6	6—7	7—8	—peak	1	2	3	4	5	6	7
C. b.	3.00	3.72	3.00	2.93	2.87	2.70	2.40	2.35	1.65	2.69	2.75	2.71	2.67	2.57	2.43	2.28
P. a.	2.26	2.15	1.88	1.75	1.31				1.13	1.82	1.93	1.79	1.75	1.54	1.43	
P. h.	1.83	2.66	2.89	3.07	4.28				3.25	1.95	2.21	2.36	2.61	3.08	2.75	

A—1: distance between the leaf base and the first hole
—peak: distance between the last hole and the peak
1—8: number of holes

Table 4

Comparisons between the growth indices of the species examined

1	2	3	4	5	6	7
Plant species	N	$\overline{GI}_{LA}$	$\overline{GI}_{HA}$	$(\overline{GI}_{LL}) \cdot (\overline{GI}_{LW})$	$(\overline{GI}_{LA}) : (\overline{GI}_{HA})$	$OMW\%$
Acer tataricum/1	40	6.70	4.31	5.89	1.55	76.79
Acer tataricum/2	40	3.42	2.66	3.17	1.28	62.40
Catalpa bignonioides	10	79.27	71.17	63.60	1.11	98.59
Platanus hybrida	10	11.07	10.92	10.38	1.01	90.84
Quercus cerris	20	2.04	1.86	2.05	1.09	46.23
Quercus robur/1	20	4.43	4.17	4.55	1.06	76.02
Quercus robur/2	54	2.16	2.34	2.13	0.92	57.26
Quercus rubra	40	11.74	13.45	10.77	0.87	92.56
Tilia argentea	40	32.42	47.40	31.72	0.68	97.89
					$\bar{x}=0.97$	

2: Number of specimens
3—6: see the explanation on p. 310.
7: Organic Matter Waste originating from the increase in hole, as a percentage of the last hole area; calculated from the data of column 4.

Platanus hybrida Brot.

The intensity in leaf growth is gradually higher in the direction from the base towards the peak, and from the main rib towards the edge of the leaf; it decreases only in the vicinity of the narrowing peaks (Table 3; Fig. 11). The average of the very different hole areas is in correlation with the leaf areas (Fig. 7c).

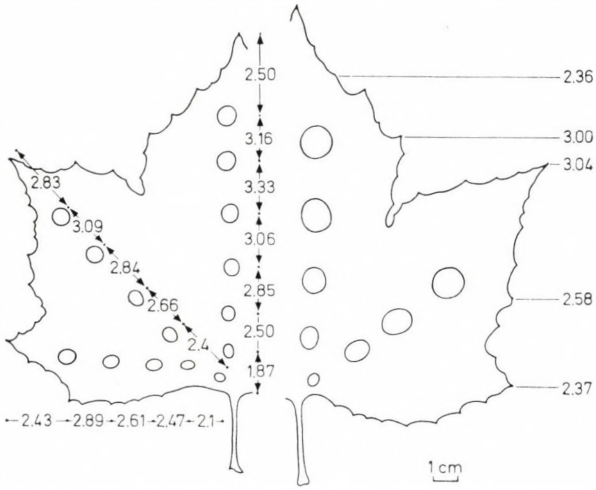

Fig. 11. Platanus hybrida leaves of apical-abaxial growth. On the left: the indices of length growth in the hole series lying along the three main ribs of the leaf. On the right: width growth indices of another leaf measured in the areas indicated by arrows

Growth data of pruned leaves

The experiment was set, in a few repetitions, in *Quercus robur* and *Quercus rubra* leaves. We removed 25, 50 and 75% of the leaf surfaces in different patterns (for example, left upper quarter, left lower quarter, apical half part, lateral half part, etc.).

According to our observations, strongly damaged leaves, which lost 75% of their surface, also continued growing and doing their assimilatory activities. Their lifetime was identical with that of the unholed leaves. At points where the leaf blade was cut too near to the main rib (within 1 mm), the remaining part bent strongly in the direction of the holing (Fig. 12).

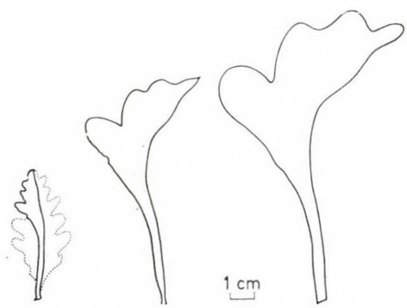

Fig. 12. Growth rate of pruned *Quercus robur* leaf (16, 20, 25 VI). The initial leaf form is indicated by dotting. The life time of the strongly pruned leaf corresponded with that of the whole leaves. The cause of the bending away was that the pruning took place too near to the main rib

According to the literature, the epidermis cells can (in the course of their elongation) grow to a size 20—30 times greater than their initial volume (MAKSYMOWYCH 1973; CARR 1972; KOZLOWSKI 1971; SINNOTT 1960). In the course of our experiment, a surface increase 14.43 times higher than the original was measured as a maximum.

Discussion

General assessments of the results

Our measurements proved unambiguously that the injured area of the leaf increases parallel with the increase in the leaf area. With the completion of leaf growth, also the increase in the hole comes to an end. Owing to the dying away of the tissues around the holes, these can expand further on.

In Table 4, the average values of the growth indices related to the individual species are given. It appears from these data that the differences between the growth indices (columns 3 and 4) are minimal. In the majority of species, the indices of increases in holes are smaller.

The connection between leaf widths and lengths, and the leaf area, is also known from the literature (KUBIČEK 1971; COOPER 1960; MILTHORPE 1956). This connection can be found also between the growth indices. The product of the multiplication between indices of length and width increases (Table 4, column 5) approximates the values of the growth indices of leaf area and hole area (column 3 and 4), and it is in general smaller by only 15%. The value of this product is especially near to the growth index of the leaf area (column 3).

Demonstrating the growth indices of a leaf group by a curve, we can easily see the very close correlation among the 3 critical values (Figs 13a and 13b). The growth graph of a chosen leaf (Fig. 14), and a comparison between the minimal, average and maximal growth indices (Fig. 15), show the correlation well.

It can be calculated from the data of column 4 in Table 4 that the area of the hole punched by us is on the average only 23% of that is the developed leaf (3 resp. 7 mm^2), while the rest, that is 77% of the whole punched area, is a result of the leaf growth (column 7)! This value depends on the time of punching, and on the state of development of the leaf.

The damages caused in various spots of the leaf blade increase to a different extent, but they are always in correlation with the individual leaf area. The cause of this is that the leaf surface also does not grow to an even extent. On the basis of the growth characters of the leaves measured in the direction of their longitudinal axis, the leaves examined were classified into the following growth types:

— *Apical types* the growth rate of the leaf is smaller at the base, it accelerates towards the peak. Growth soon stops at the base, and it finishes at the peak at the latest.

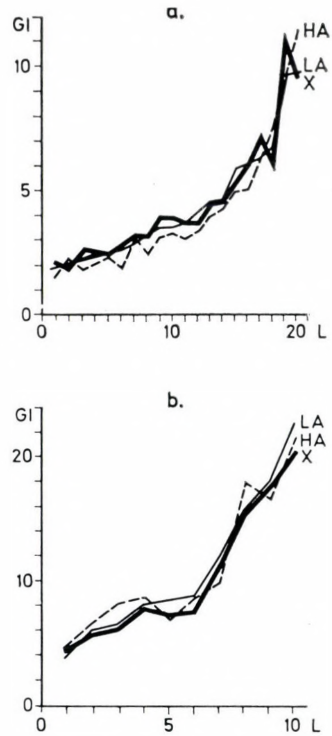

Fig. 13. Growth indices in the rising order of values. a) 20 *Quercus robur* leaves; b) 10 *Platanus hybrida* leaves. L: number of leaves: GI: growth index: LA: leaf area; HA: hole area; X: the product of multiplying the leaf width by the leaf length

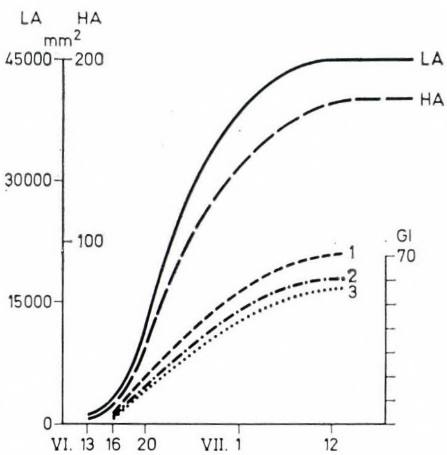

Fig. 14. Growth curve of a *Catalpa bignonioides* leaf. On the linear coordinate: times of observation. LA: leaf area, HA: hole area, GI: growth index. *1* growth index of leaf area; *2* growth index of hole area; 3 product of multiplying the growth indices of leaf length by leaf width

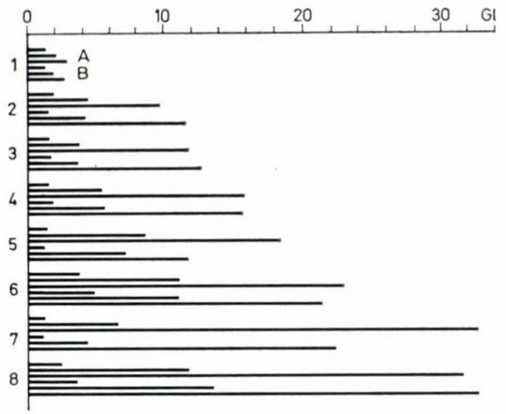

Fig. 15. Minimal, average and maximal growth indices of the leaf areas (A) and the hole areas (B) of five examined plant species. *1 Quercus cerris, 2—4 Quercus robur, 5, 7 Acer tataricum, 6 Platanus hybrida, 8 Quercus rubra*

— *Basal type.* Growth finishes at the peak and its vicinity the soonest, and in the vicinity of the base the latest.

— *Medial type.* Growth rate is highest at around the leaf centre; it decreases towards the base and the peak.

On the basis of the growth observed in the direction vertical to the longitudinal axis, a further two types can be distinguished:

— *Abaxial*: the growth rate increases in the direction from the main rib towards the edges of the leaf.

— *Axial*: the growth rate increases in the direction from the edge of the leaf towards the midrib.

On the basis of what has been said above, we can state that the leaves of, for example, *Platanus hybrida* are apical-abaxial; those *Populus alba* are basal-axial; and of *Ailanthus altissima* medial.

These growth types are not identical with the basiplast and pleuroplast developmental types described in the morphological literature (Schüepp 1966), or with the adaxial and marginal growth forms (Cutter 1961; Esau 1965; Cloves 1961).

In many cases, the form of the holes lying in the grown leaves is strongly distorted. This can have many causes:

— The punching of the leaf took place at a time when the young leaf blade had not yet become smoothed and the original injury had also not been of a circular form (for example, *Tilia*, Fig. 8).

— One edge of the hole touched a large rib and the hole increased alongside the rib further in a straight line.

— As a result of the holing which tore the main rib or the secondary rib, the leaf form became distorted. In case of injury to a main rib, the peak in-

clined downward, in many cases it became destroyed, when a secondary rib was injured, the side with the hole in it began to shrivel. Thus the hole became irregular, and owing to the shrivelling difficult to measure.

— Holes grown to an elliptical or oval form are frequent. This was always observed in rib angles (see Figs 6 and 10). The longer axis of the hole shows the direction of stronger growth.

In addition to the causes mentioned above (multiplication, extension, differentiation), the increase in the holes can be influenced by the fact that the cells in the sphere of the hole die away. For example, the dying away could be observed in a band of 140—150 micron in *Acer platanoides*, and in a band larger than 1 mm in the case of *Catalpa* and *Platanus*.

In a few cases, the tissue structure of the holing zone was examined. It was found that the leaf narrows in the direction of the hole, the palisade layer disappears, and the injury becomes covered by a tissue consisting of parenchymatous cells, with a thick cuticle on the marginal cell row.

Estimation of the initial size of the damage

On the basis of our results, the possibility may arise for a more accurate explanation of the activity of foliage-consuming organs.* According to the examinations carried out in the "Sikfőkút Project" area in 1973—75, the *Quercus petraea* leaves had an average weight of 4.95 mg/cm^2 at the beginning of May, and in the middle of August they had 9.5 mg/cm^2 (VIRÁGH 1977). This means that if the area of the hole consumed in the leaf did not grow, 1 cm^2 of the leaf area consumed in May would represent a leaf phytomass loss of 4.55 mg/cm^2 during 3.5 month for the plant. If on the other hand we calculate that the hole area increases five times to its initial size at least, then the lack of 1 cm^2 leaf area will mean a lack of 47.5 mg phytomass by the time of the completion of growth, that is, in comparison with the actual consumption, the damage can be even ten times greater. Moreover, this value does not include the lack of the organic matter that as a result of the missing operation of the disappeared assimilatory surface is transported away from the leaf. Thus, the insect causes much greater damage indirectly, with the organic matter waste originating from growth than it does directly by its consumption.

It is also a fact that the plants in the stand, being in a dynamic equilibrium, can to a certain extent compensate these losses by developing new shoots and leaves — this, however, does not alter the above facts.

The period of leaf growth is rather short. According to BÜSGEN and MÜNCH (1931), the greatest extension of oak leaves take place in 10—14 days. MOORE (1965), *Acer* and *Parthenocissus* put the time of growth and aging of

* Although the experiments were carried out in Debrecen, our observations can be taken as of general validity.

leaves at 80 days each in the course of the 200-day life-cycle. KIENHOLZ (1941) describes a 30-day growth period in the case of white ash, beech and red oak. According to JOHNSTON (1941), the *Quercus alba* and *Qu. stellata* leaves grow only for 19 days, and 90% of their growth takes 11 days. From our own mesurements, carried out in 1977, it can be established that the leaves of the trees examined finish their growth in 3—4 weeks; the most intensive phase is limited to 7—15 days (see Fig. 14). The greatest damage generally occurs in this period.

To ascertain actual extent of the damage caused by holing, a satisfactory point of departure is given by the fact that the product of multiplication between indices of leaf growth in width and those in length is in correlation with the indices of area increase; on the other hand, there is a close relationship between the growth indices of leaf areas and hole areas. Taking all this into consideration (by knowing the time of shooting, growth and of the insect consumption in leaves), we can operate with the following equation:

$$HA_1 = \frac{HA_2}{(GI_{LL}) \cdot (GI_{LW}) + a} + b; \quad \text{or} \quad HA_1 = \frac{HA_2}{GI_{LA}} + b$$

where

HA_1 = the hole area to be found (consumed surface), mm^2
HA_2 = consumed surface measured (estimated) at the time of assessment, mm^2
GI_{LL} = growth index of the leaf length
GI_{LA} = growth index of the leaf area
a = 10% of the product of multiplication between indices of growth in length and in width
b = correction

Correction is necessary because of the uneven growth of the leaf blade. According to our observation so far, the value of correction can be taken an zero in the middle one third of the leaf, and in the upper and lower thirds it is negative or positive according to the growth type of the leaf.

The estimation method was checked with the help of our experimental material. In the course of the investigations, the method can be further improved. Knowing the leaf weights given for 1 cm^2 surface, the insect damage can be estimated not only for surface but also for weight.

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MUTAGENIC EFFECTS OF PESTICIDES; I. CYTOLOGICAL EFFECTS ON SOME SUBSTITUTED UREA HERBICIDES IN BARLEY

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Substituted urea-type active ingradients of nine herbicides (diuron, linuron, monolinuron, chlorbromuron, metoxuron, isoproturon, metobromuron, methabenzthiazuron, chloroxuron) were tested for introduction of chromosome aberration and inhibition of seed germination in barley (*Hordeum vulgare* L.). The lethal and LC_{50} values were estimated for active ingredients of each herbicide. Lethal dose values were found between 300 and 1200 ppm, the LC_{50} values were estimated to be between 250 and 1000 ppm.

The mutagenic effects proved to be different in each chemical as judged by the root tip metaphase analyses. The frequencies of aberrant cells were ranging between 2.54 and 10.97 per cent. Aberration frequency exceeded that of 2.3×10^{-3} M EI treatment (5.96%) in the case of monolinuron (10.97%), chlorbromuron (8.06%), metobromuron (6.68%) and methabenzthiazuron (6.26%), but they never reached the γ-ray (10 000 R) treatment level (12.06%). The prolongation of the treatment greatly increased the frequency values of the aberrations in the case of methabenzthiazuron, chlorbromuron and isoproturon. Increase of herbicide concentration resulted in higher proportion of fragments in the aberrant cells. Each herbicide induced predominantly chromatid type aberrations like the EI. The duration of the treatment did not influence the type of chromosomal changes.

Introduction

Increased application of pesticides in agriculture in the last few years has led some workers to investigate genetic alterations caused by these chemicals (Veleminsky and Gichner 1963; Wuu and Grant 1966; Ahmed and Grant 1972). In practice, however, pesticide effects were usually confined to economic questions and toxicity tests on the crop plants neglecting the possible genetic effects. In Hungary Füredi et al. (1975) investigated the effects of certain pesticides on different pea strains. They could not find increased mutation rate in the filial generations.

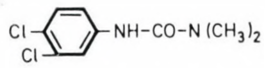
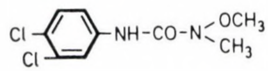
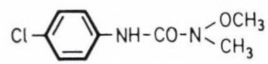
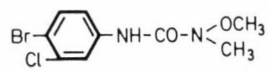
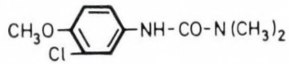
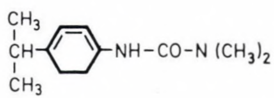
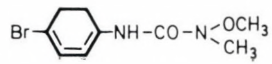
The universality of the genetic material theoretically permits rough estimations of chemicals in different test systems (e.g. gene mutations in microbial system, chromosome aberrations in plants, etc.).

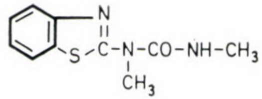
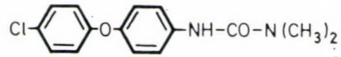
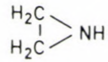
Among higher plants the barley (*Hordeum vulgare*) appears to be suitable for mutagenic testings, because it has low chromosome number, relatively large chromosomes where structural changes are easily detectable.

Herbicides of substituted urea-type have long been widely used in agriculture. Their mutagenic effect, however, has hardly been considered, although their chemical structure suggest this possibility. For this reason we chose to study the genetic effects of substituted urea-type herbicides currently applied in Hungary. The present paper reports on cytogenetic effects observable in barley root tips after treatments with nine different herbicides.

Table 1

Trade names, composition and chemical structure of the compounds tested

Common name	Chemical name	Structural formula	Trade name
Diuron	(3-/3,4-dichlorophenyl/-1,1-dimethyl-urea)		Lucenit 80 WP
Linuron	(3-/3,4-dichlorophenyl/-1-methoxy-1-methylurea)		Afalon 50 WP
Monolinuron	(3-/4-chlorophenyl/-1-methoxy-1-methylurea)		Aresin 50 WP
Chlorbromuron	(3-/4-bromo-3-chlorophenyl/-1-methoxy-1-methylurea)		Maloran 50 WP
Metoxuron	(3-/3-chloro-4-methoxy-phenyl/-1,1-di-methylurea)		Purivel 80 WP
Isoproturon	(1-/4-isopropylphenyl/-3,3-dimethyl-urea)		Arelon 50 WP
Metobromuron	(3-/4-bromophenyl/-1-methoxy-1-methylurea)		Patoran 50 WP

Methabenzthiazuron	(1-/2-benzothiazolyl/-1,3-dimethyl-urea)		Tribunil 70 WP
Chloroxuron	(3-[4-/4-chlorophenoxy/phenyl]-1,1-dimethylurea)		Tenoran 50 WP
	ethylenimine		

All the chemicals were provided by the Institute for Plant Protection, Budapest.

Material and methods

From the substituted urea-type herbicides currently used in the Hungarian agriculture nine were tested. Treatment were made with active ingredients. Their international, trade and chemical names, structural formats are listed in Table 1.

Chemical substances were dissolved in distilled water, dimethylsulfoxide (DMSO) or methanol, according to their solubility. Monolinuron and metoxuron were dissolved in water; diuron, linuron, chlorbromuron, metobromuron, and chloroxuron at first in DMSO, isoproturon and methabenzthiazuron at first in methanol and diluted with water afterwards.

For the cytological test a Hungarian strain of diploid barley (*Hordeum vulgare*, Mv-43, $2n = 14$) was used. The effects of DMSO and methanol in the final concentration (0.2%) was also checked and found to be identical with the water control.

In order to estimate the toxic effects on the seedlings, each herbicide was studied in a series of concentrations from 100 to 1200 ppm. Depending on the toxicity, seeds were treated with 100 to 600 ppm solutions for the cytological tests. For investigation of dose effect, each chemical was applied in three different concentrations. The duration at treatments was 6 or 12 hours.

As negative control distilled water, as positive control 10 krad γ-ray (^{60}Co, 384 rad/min) and 2.3×10^{-3} M ethylenimine (EI) was used. The alkylating agent (EI) was applied for 3 hours.

The treatments with the herbicides were run in 4—4 parallels and their total results are presented here. Significancy was studied with *t* test. 200 barley seeds were germinated in each experiment, 50 in each parallel. The 50 dry seeds were placed into 200 ml herbicide solution for 6 or 12 hours. Then the seeds were washed in running water and placed on moist filter paper in a Petri dish, and kept in 24 °C thermostat for 26—36 hours. After the estimation of germination per cent, 3—5 mm long root tips were chosen for cytological analysis. The analysis was made on metaphase chromosomes of the dividing root tip meristem cells. In order to accumulate metaphase plates, the germinating seeds were pretreated with 0.01 per cent colhicine solution. Fixation, staining and squash preparations were done according to GILYAROVSKAYA (1973).

Experimental results

1. The effects of herbicides on the germination of barley seeds

The nine herbicide chemicals were tested in different concentrations with 6 and 12 hours treatments, respectively. Figure 1 illustrates the germination decreasing effects, the lethal and LC_{50} values. Chemicals are groupped in Fig. 1 according to their toxicity. 6 and 12 hours long treatments are presented separately. It can be concluded, that some herbicides (methoxuron, methabenzthiazuron and monolinuron) are not influenced by the length of the treatments, while others show considerable differences of LC_{50} values and letality after 6 or 12 hours. Treatments with metoxuron, chlorbromuron and methabenzthiazuron show 10% decrease of germination below LC_{50} dose in the 12 hours treatment.

It is clear from Fig. 1, that lethal and LC_{50} values are very different in the nine chemicals. Diuron virtually inhibits germination at 300 ppm, while similar effect can be achieved with chloroxuron at 1200 ppm only.

The LC_{50} values also reflect the toxicity differences above mentioned. The lowest concentrations used in our experiments did not influence the germination after 6 hours treatment. In the case of chloroxuron even the 12 hours 400 ppm treatment was not different from the negative control. This herbicide resulted decreased germination only at 600 ppm and higher concentrations.

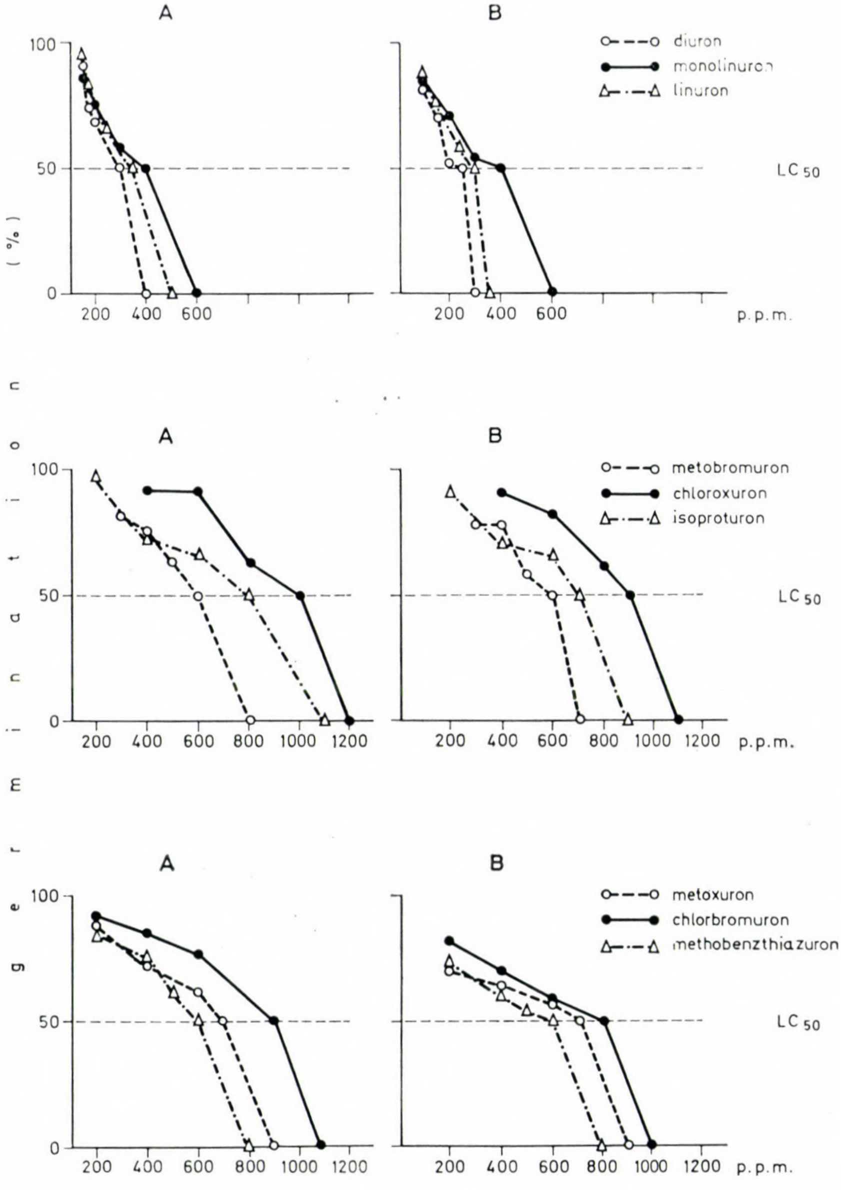


Fig. 1. Effect of exposition and herbicide concentration on germination of barley. A — 6 hours, B — 12 hours

Concentrations below the LC_{50} values exhibited concentration depending effects after 6 hours with strongly toxic substances only. Dose relationship is more obvious after 12 hours with each chemical.

Table 2

Frequency and distribution of types of chromosome aberrations induced by herbicides in Hordeum root tips

Herbicides	Treatment time (hours)	Concentration (ppm)	Total no. cells	Total no. abnormal cells	Abnormal cells: Distribution: chromatid type: fragment	isochromatid deletions	interchanges	chromatid ring	chromosome type: fragment	dot deletion	ring	dicentric	Others	Percentage: abnormal cells	Mean for each time period	Mean for each herbicides
Diuron	6	100	672	11	3	2	5		1					1.63±0.49		
		150	475	18	3	5	6	1			2	1		3.79±0.88	2.50	
		200	373	9	2	5	2							2.41±0.49		2.54
	12	100	691	14		7	5			2				2.02±0.53		
		150	609	16	3	8	2				3			2.62±0.65	2.59	
		200	286	11	1	2	8							3.84±1.14		
Linuron	6	100	683	15		2	10						3	2.19±0.56		
		150	489	21	5	8	4	1				1	2	4.29±0.92*	4.65	
		250	396	37	16	10	7						4	9.34±1.46***		5.79
	12	100	636	19	6	2	10			1				2.98±0.67		
		150	672	76	27	25	19		2				3	11.31±1.22***	6.87	
		250	321	17	8	4	4						1	5.29±1.25**		
Monolinuron	6	100	696	20	3	6	10						1	2.81±0.72		
		200	681	117	45	37	24	3				3	5	17.18±1.40***	10.45	
		300	343	60	21	14	18	2				2	3	17.49±1.75***		10.97
	12	100	632	22	2	4	16							3.48±0.73		
		200	653	94	21	13	49	3				3	5	14.39±1.75***	11.46	
		300	341	54	15	12	9	5		2		5	6	15.83±1.98***		

Chlorbrom-uron	6	200	639	14	1	5	8							2.19±0.58		8.06
		400	671	68	27	12	19	4				4	2	10.13±1.16***	6.36	
		600	389	26	10	5	7			1			3	6.68±1.26***		
	12	200	543	45	5	10	26	2				2		8.29±1.18***		
		400	621	76	30	17	24						5	12.23±1.40***	9.90	
		600	401	34	14	7	10						3	8.48±1.40***		
Metoxuron	6	200	601	17	2	7	8							2.83±0.68		3.34
		400	486	11	3	3	3						2	2.26±0.81	3.27	
		600	379	29	1	7	11						1	5.28±1.15**		
	12	200	686	23	3	9	11							3.35±0.69		
		400	503	15	3	4	7						1	2.98±0.79	3.40	
		600	340	14	4	2	5						3	4.11±1.30		
Isoproturon	6	200	635	21	6	9		2	2				2	3.31±0.71		5.57
		400	732	37	12	7	11	1	2		1		3	5.05±0.81***	4.36	
		600	398	19	5	6	6					2		4.77±1.07*		
	12	200	643	31	3	7	17	1	1				2	4.82±0.84*		
		400	539	49	16	8	17		4				4	9.09±1.48***	7.01	
		600	301	24	7	7	8			2				7.97±1.75***		
Metabrom-uron	6	300	635	22	2	4	12				1		3	3.46±0.85*		6.68
		400	732	66	15	20	22	3	4				2	9.01±1.11***	6.74	
		500	398	31	15	4	6					3	3	7.79±1.34***		
	12	300	631	31	3	7	18	2					1	4.19±0.71*		
		400	509	42	6	19	9		5				3	8.25±1.15***	6.61	
		500	372	27	8	8	6			3			2	7.25±1.14**		

* Significant at 0.05 level of probability.
** Significant at 0.01 level of probability.
*** Significant at 0.001 level of probability.

Table 2 *(Continued)*

Frequency and distribution of types of chromosome aberrations iuduced by herbicides in Hordeum root tips

Herbicides	Treatment time (hours)	Concentration (ppm)	Total no. cells	Total no. abnormal cells	Abnormál cells — Distribuition — chormatid type: fragment	isochromatid deletions	interchanges	chromatid ring	chromosome type: fragment	dot deletion	ring	dicentric	Others	Percentage: abnormál cells	Mean for each time period	Mean for each herbicides
Methabenz-thiazuron	6	200	601	16		5	7	1	2			1		2.66±0.55		6.26
		400	429	20	4	1	11					2	2	4.66±1.02*	3.57	
		500	343	13	3	6	3					1		3.13±0.81		
	12	200	678	32	6	4	15		4	1		2		4.72±0.81*		
		400	722	85	30	20	22		7		1		5	11.77±1.20***	8.20	
		500	503	39	17	8	10	2				2		7.75±1.19***		
Chloroxuron	6	400	781	19		4	12		3					2.43±0.49		3.13
		600	588	22	5	3	8		1			2	3	3.14±0.67	3.20	
		800	409	16	1	7	5					1	2	3.91±0.80		
	12	400	678	14	3	4	3		2				2	2.06±0.54		
		600	532	19	1	6	10					2		3.57±1.01	3.04	
		800	401	16	1	5	7		3					3.99±0.98		
EI	2.3×10^{-3}M		1123	67	19	10	25	4	2	3		4		5.96±0.71		
γ-rays	10 krad		1287	168	5	8			25	9	36	85		12.06±0.91		
H_2O			1721	34	9	15	4			2	1	3		1.97±0.33		

* Significant at 0,05 level of probability.
*** Significant at 0,001 level of probability.

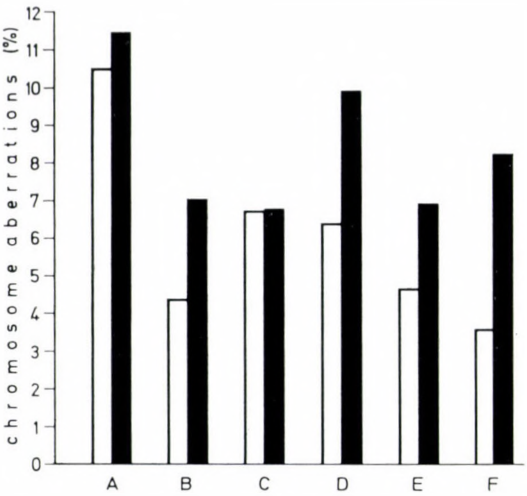


Fig. 2. Percentage of chromosome aberrations induced by herbicides in barley root tips. (A) monolinuron, (B) isoproturon, (C) metobromuron, (D) chlorbromuron, (E) linuron, (F) methabenzthiazuron. □ 6 hosur ■ 12 hours

2. *Cytological effects of the herbicides*

In order to study the cytological effects of the active ingredients of herbicides, suitable positive and negative controls were selected. γ-ray and EI were used as positive controls while germination in water was applied as the negative one. The doses of the positive control were calculated not to decrease germination below 90%.

Doses at or higher than LC_{50} concentrations strongly decreased cell divisions, therefore lower values had to be applied. Doses of treatments were chosen where the decrease of mitotic divisions did not extend 50 per cent. The cytological results are presented in Table 2 and Fig. 2.

As can be seen in Table 2 the two positive controls, the γ-ray and the EI treatments, caused chromosome aberrations in 12.06% and 5.96%, respectively. The majority of herbicides similarly caused chromosome structural changes. The frequency of aberrations in diuron and chloroxuron treatments has not proven to be significantly higher than that of the negative control. Trea tments with metoxuron exhibited significant ($p < 0.05$) effect at 600 ppm only.

The other chemicals caused chromosome aberrations with various frequencies. The strongest effect was observed in treatments with monolinuron and chlorbromuron reaching 10.97% aberrations.

The prolongation of the treatments to 12 hours usually increased the effect. The highest increase was found with methabenzthiazuron. Monolinuron and chlorbromuron also considerably amplified the effect.

Monolinuron, chlorbromuron, metobromuron and methabenzthiazuron caused aberrations in higher percentage than EI but did not reach that of the γ-ray.

The types of aberrations are also summarized in Table 2. γ-ray treatments caused predominantly (72% of all abnormalities) reunion-type dicentric, ring) damages and less frequently (15%) breaks. The EI treatments are characterized by chromatid-type aberrations. Out of the aberrations observed 66% were chromatid translocation type and about 15% fragment. The majority of spontaneous aberrations found in the water control was chromatid type, 61% being translocational and 26% fragment.

The aberrations observed after herbicide treatments were also mainly chromatid-type aberrations. The type of aberrations did not change with the different herbicides or with the duration of treatment, but it is apparently effected by their concentrations. Higher doses increased the probability of fragmentations as compared with translocational types.

In the case of monolinuron treatments for example, the proportion of fragmentation is 15% after 100 ppm treatment and 31% after 200 ppm. On the other hand, similar values for translocation are 80% and 59%, respectively.

Our statements on dose dependence are valid for the lower concentrations only, because of the characteristic relationship of cytogenetic and toxic effects. The different aberrations mentioned in Table 2 are illustrated in Figs 3—5.

Discussion

It is crucial to distinguish the toxic and mutagenic components of the biological effects of herbicides. In assessing their impacts in the environment the two effects should be considered with different stress. Most of the pesticide studies so far published cover the toxic effects only. Some papers dealing with cytogenetic effects on barley (Wuu and Grant 1966; Gichner, Caul and Omura 1968) study the aberrations observed at anaphase. Our results with analysis of metaphase abnormalities show considerably more detailed picture. The frequency of aberrations at metaphase is 1.5 to 2 times higher than that of the anaphases (Conger 1965). Metaphase analysis therefore better ensure the quantitative as well as qualitative assessments of aberrations.

In our experiments the active ingredients of herbicides interferred, although to different degrees, with the germination and also caused chromosome abnormalities. The highest toxicity was found in treatments with diuron and linuron, while the lowest such effects were found with chloroxuron and chlorbromuron. Comparing toxicity and mutagenicity it can be concluded that with certain chemicals higher toxicity found at prolongated treatments does not mean increased chromosome aberrations as well. In the chlorbromuron and methabenzthiazuron treatments the decreased germination rates were paralleled with increased mutation rates while similar relationship has not been

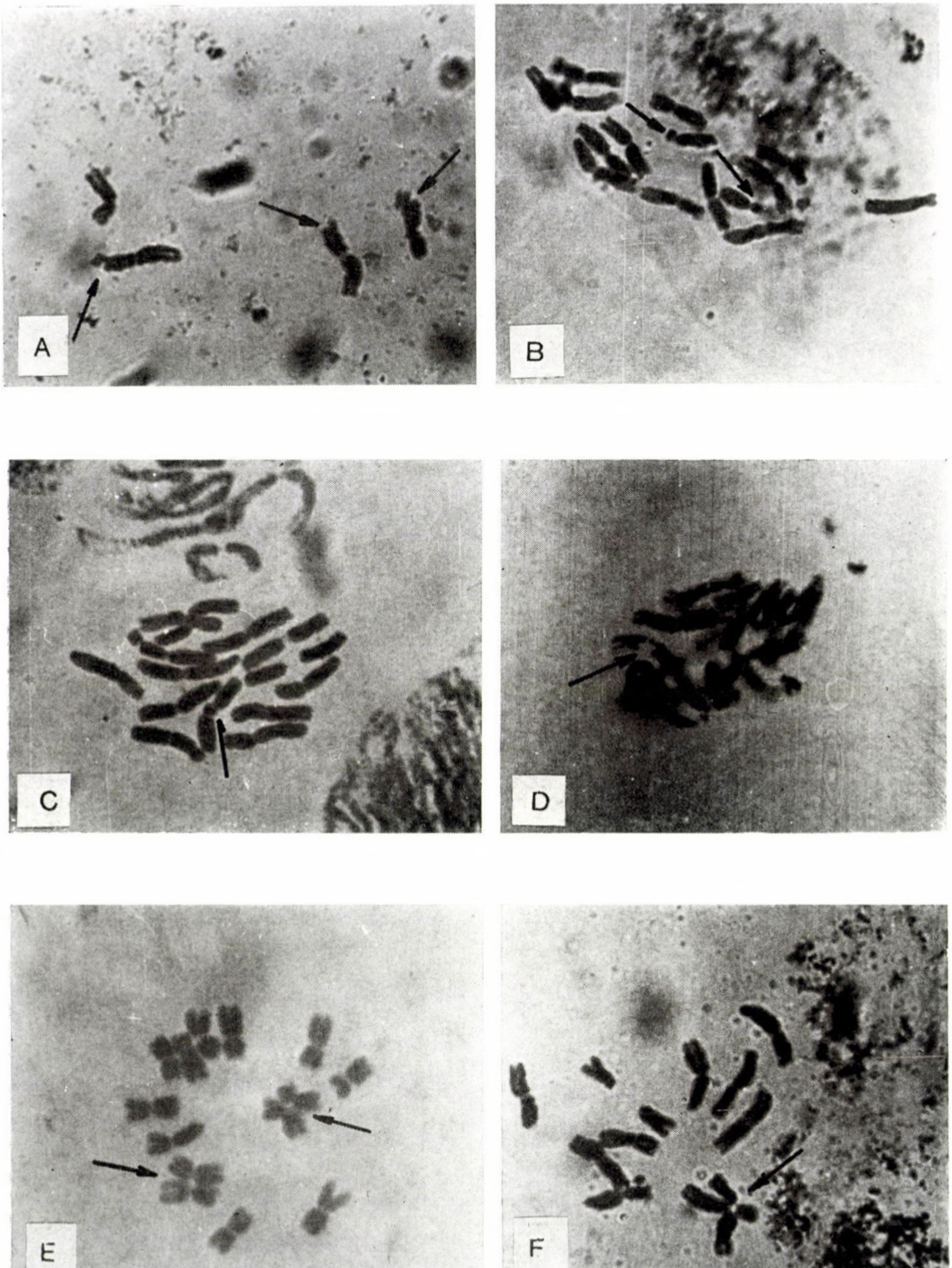


Plate 1. Chromatid-type aberrations observed in *Hordeum* root tip cells. (A) Chromatid breaks (fragment). (B) Chromatid acentric ring. (C—D) Isochromatid break with sister chromatid reunion. (E—F) Chromatid interchange

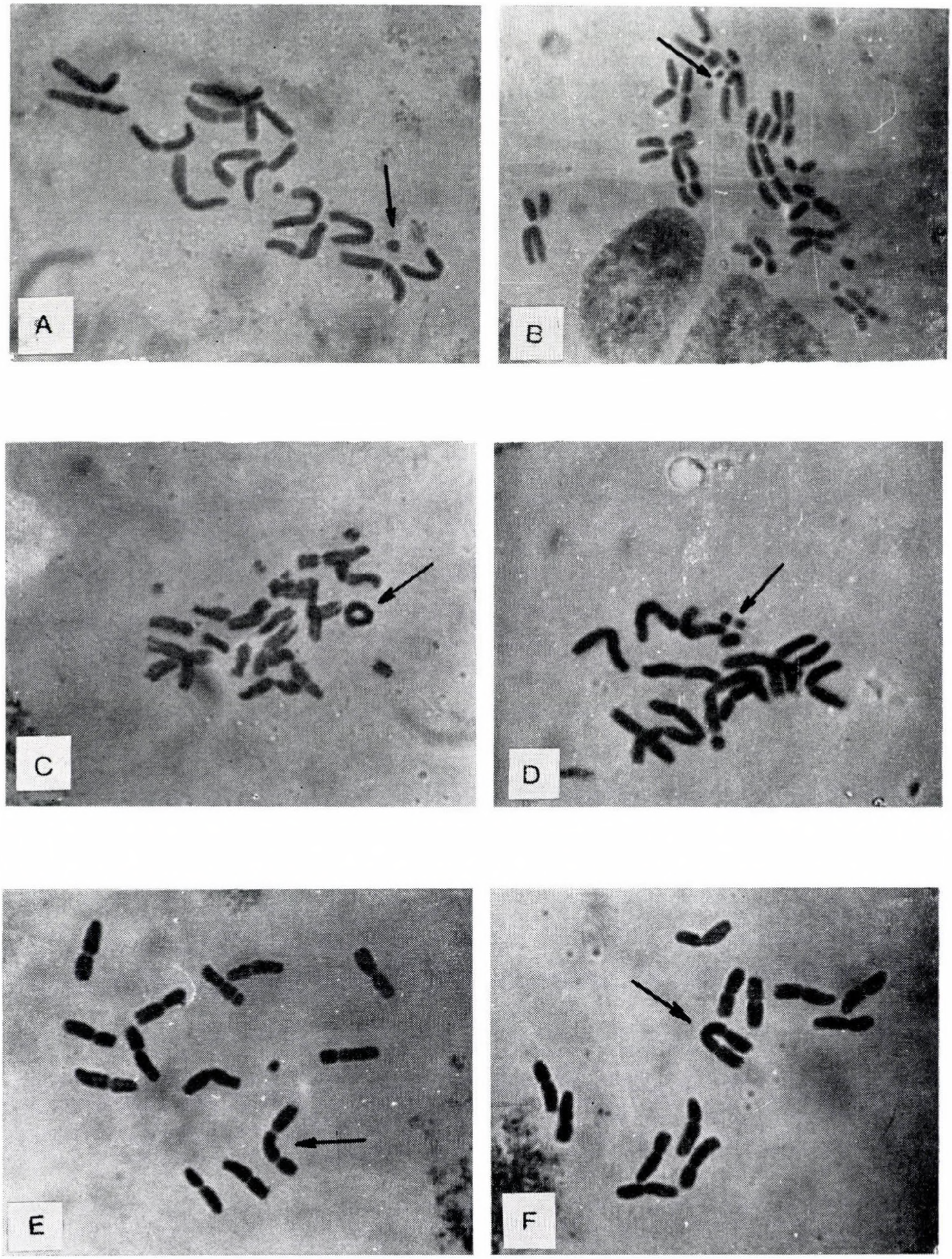


Plate 2. Chromosome-type aberrations observed in *Hordeum* root tip cells. (A) Acentric fragment (terminal deletions). (B) Dot deletions (interstitial deletions). (C) Centric ring. (D) Acentric ring. (E—F) Dicentric aberrations (asymmetrical interchange)

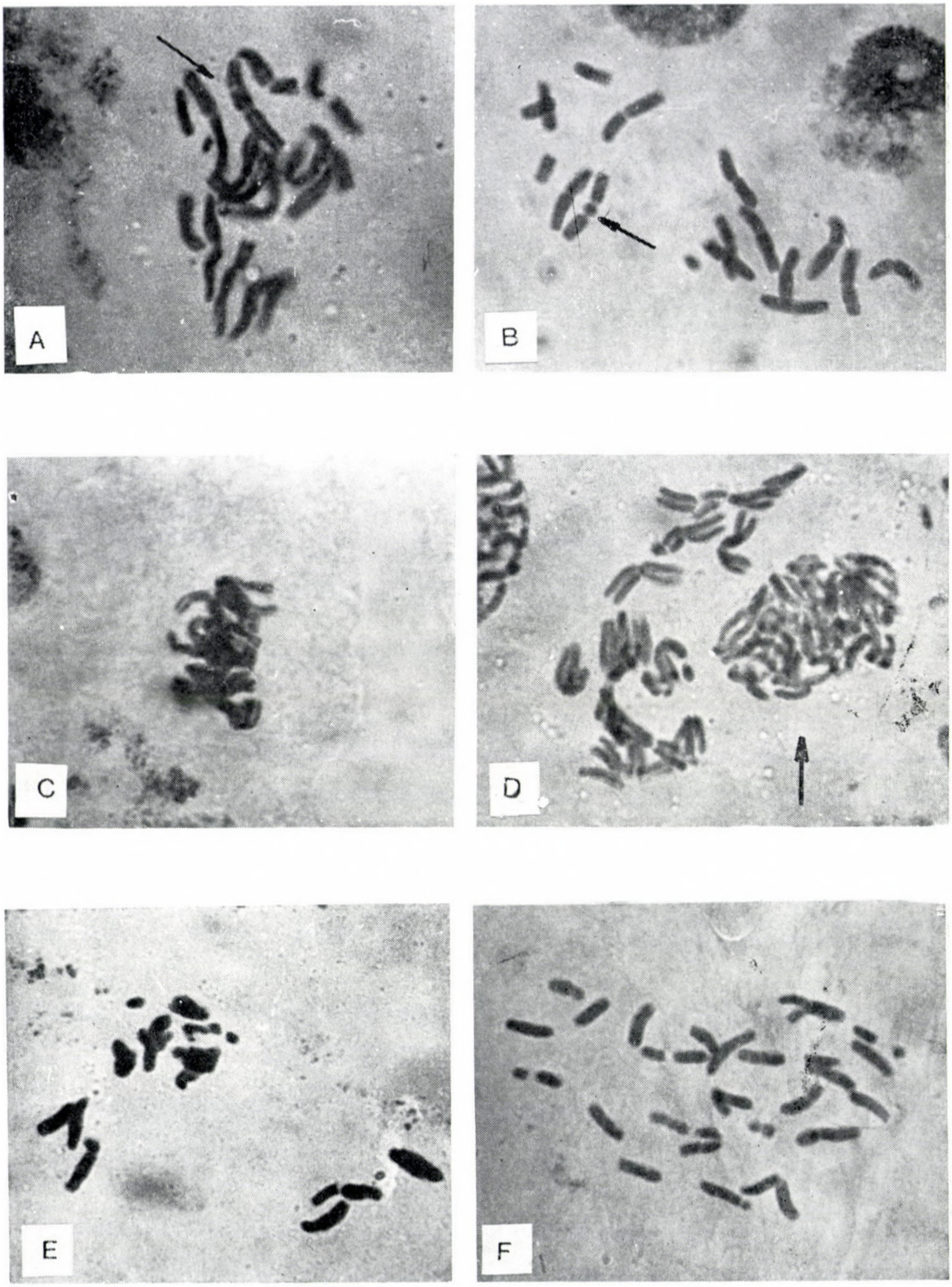


Plate 3. Types of aberrations observed in *Hordeum* root tip cells. (A) Chromatid-type gap. (B) Chromosome-type gap. (C—D) Chromosome clumping. (E) Chromosome stickiness. (F) Extreme fragmentation of chromosomes.

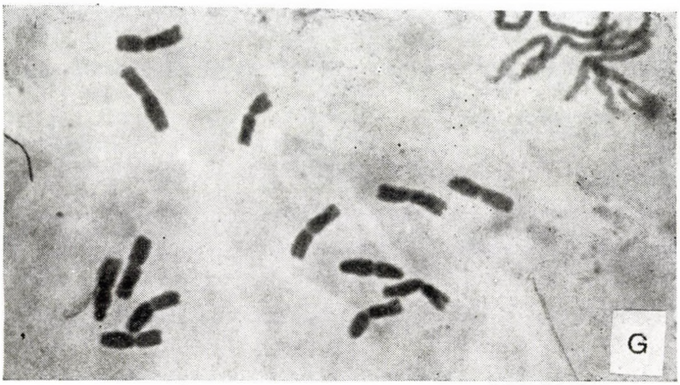


Fig. 3. Normal chromosome set of *Hordeum* root tip cells (G)

observed in the metoxuron treatments. On the other hand, the prolongation of the treatments of isoproturon resulted in higher chromosome aberration frequency but apparently did not change germinability.

Cytogenetic effects of herbicide treatments were detected as breakage and reunion-type aberrations. As a result of chromosome or chromatid breakage, dicentric chromosome, ring, isolocus break with reunion or translocation could be observed in the microscopic preparations. Gaps sometimes observed on chromosomes can be regarded as achromatic lesions unstainable with the Feulgen method (Evans et al. 1975). Breaks induced by chemical mutagens and ionizing radiation have been reported by several authors (e.g. Evans 1962; Kihlman 1966).

In our experiments the γ-ray irradiation caused more reunions as fragments, while the other positive control, EI induced reunions and fragments almost in the same amount. The herbicide treatments produced mostly chromatid-type reunions, fragments appearing largely at higher concentrations only.

The mechanism of chromosome breakage and reunion is not clearly understood. Hypothetic explanations are given by Revel (1958) and Wolff (1963).

Published results regarding mutagen effects of substituted urea-type chemicals are contradictory. Wuu and Grant (1966) found monuron and linuron to be mutagenic. Among the substituted ureas N-nitroso-N-methyl urea and N-nitroso-N-ethyl urea are also mutagens, their effect has been demonstrated in barley (Gichner 1968). On the other hand, Tomkins and Grant (1972) could not find chromosome aberrations in metobromuron treatments, only physiological effects were observed (growth retardation and decreased germinability). Mutagen effect of metobromuron demonstrated in

our experiment in possibly due to the different dissolving procedure (the above authors used only water). Similarly ,the different mutagenic and physiological effects of the nine chemically very similar herbicides ought to be explaned. Perhaps chemical and or physico-chemical properties of the molecules (such as structure, hydrophilic or hydrophobic nature, etc.) are responsible for biological differences, like cell membrane permeability or interference with various metabolic pathways, which in turn realize the observed effects. It follows, therefore, that active ingredients like the diuron, which was so toxic to barley, that we could not detect its putative mutagen effect in a reliable way, might be mutagenic in some other test systems. The supposed mutagen nature of the chemicals we tested has been proven in our experiments but further studies are required to clarify the reasons of the observed differences.

The mechanism of the action herbicides is known in few cases only, and this is understandable considering the complicatness of the effect. It is known however, that chromosome stickiness, sometimes also observed in our experiments, can be connected with disturbations of nucleic acid metabolisms (DARLINGTON 1942) induced by the herbicide treatment. Presumably, the toxic and mutagenic effects are not expressed directly on the nucleic acids but rather indirectly trought proteins or enzyme systems.

Regarding the practical application of herbicides our general conclusion is that toxic and mutagenic doses of a certain chemicals are often different. A concentration toxic for the weed occasionally might reach the mutagenic dose level of the cultivated crop plants. This may cause cummulative genetic harm in the progeny of a seed-corn growing culture. Beside the toxicological test the genetic risk estimation is therefore also necessary in the case of each crop plant.

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CHROMOSOME ELIMINATION IN ALLOPLOID TOBACCO HYBRIDS

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A decreased chromosome number (2n=48) derivate (F_5) of the alloploid hybrid (2n=72) of *N. tabacum* (Kentucky) × *N. glauca* was used to raise "haploid" plants by anthere culture.

Karyotype analysis of the plantlets with 24 chromosomes indicates that some chromosomes of *N. tabacum* were eliminated.

Comparative isoenzyme and protein analyses prove that there was autosyndetic chromosome pairing in the pollen mother cells of the alloploid. Activities of esterase isozymes seem to be controlled by the relationship of structural and regulatory genes concerned. The presence of regulatory genes suggested by the observed interaction of genomes before and after some chromosome elimination.

Introduction

In a previous study chromosome elimination was reported during F_2—F_4 generations of the alloploid hybrid *Nicotiana tabacum* (Kentucky) × *N. glauca* (SZILÁGYI 1975). All the F_5 plants of this hybrid showed stable and uniform phenotype with 2n=48 chromosome number. Their white flower differed from both parental species. Flowers of *N. tabacum* (Kentucky) are pink, while those of *N. glauca* are greenish-yellow coloured. The original F_1 hybrid showed 2n=72 chromosomes. Karyotype analysis of the F_5 plants suggested that the 12 missing chromosome pairs belong to the *N. tabacum* genom. Since *N. tabacum* itself is a putative alloploid of *N. sylvestris* and *N. tomentosiformis*, the eliminated chromosomes could well be members of both ancestral genomes (SZILÁGYI 1975). In order to clarify further this problem we have raised "haploid" plants of this modified alloploid.

Haploids made of interspecific *Nicotiana* hybrids have scarcely been reported in the literature. GUO (1972) using anthere cultures raised only haploid callus of *N. suaveolens* × *N. langsdorfii*, while SMITH (1974) managed to produce a haploid plant of *N. glauca* × *N. langsdorfii*. There is no report on cytological and biochemical characterization of these hybrids.

Analysis of isoenzyme pattern has often been applied as genetic marker in interspecific hybrids, alloploids and aneuploids. GANAPATHY and SCANDALIOS (1973) reported different MDH isoenzymes in *Datura* species. CARLSON (1972) compared isozymes of normal diploid and those of different trisomics in *Datura stramonium* in order to localize structural genes involved on the basis of the gene dose-isoenzym activity relationships.

Similarly, an interdependence of gene dose and peroxydase activity per cell was observed in ferns of different ploidy level, but with higher ploidy level certain isoenzymes increased others decreased in activity (DEMAGGIO and LAMBRUKOS 1974). In wheat-rye hybrids (8 × *Triticale* and *Secalotricum*) cytoplasmic as well as structural and regulator effects were suggeste in the expression of phosphodiesterase isozymes (WOLF and LERCH 1974, WOLF and RIMPAU 1977). A detailed analysis of *Nicotiana* alloploids revealed additive, dominant and reciprocal different interactions of isozymes (SMITH et al. 1970).

We report here on the haploidization of our *Nicotiana tabacum* (Kentucky) × *N. glauca* alloploid derivate in connection with the process of chromosome elimination as revealed by comparative protein and isoenzyme pattern.

Material and methods

Haploid plants were raised using anthere cultures (NITSCH and NITSCH 1969) of *Nicotiana tabacum* (Kentucky) × *N. glauca* alloploid derivate with decreased chromosome number (2n=48).

All the plantlets were kept thereafter on a culture medium containing mineral nutrients (KOVÁCS 1971) in controlled chamber at 25 (±2) °C with 12 hours light and 12 hours dark periods.

Cytological preparations were made on root tip squashes with ordinary acetocarmine staining. Karyotypes were obtained by arranging the chromosomes according to the position of centromeres (SZILÁGYI 1975).

Analyses of proteins and isozymes were done on leaf samples collected after the dark period. Separation on polyacrylamide gel was studied of extracts obtained in same quantity (10 mg) of fresh leaves. Isoenzymes were identified by specific stainings (SCANDALIOS 1969, WOLF and RIMPAU 1977). Soluble leaf proteins were analysed using SDS gel electrophores and Coomassie blue G 250 dye (WEBER et al. 1972, SCHLESINGER et al. 1972, BLAKESLEY and BOEZI 1977).

Experimental results

Anthers placed on sterile nutrient produced shoot and subsequently root primordia in five weeks (Fig. 1). The 8 weeks old young plantlets were transferred to mineral nutrient (KOVÁCS 1971) and 3 weeks later potted into soil (Fig. 2).

Several root tips were checked in each plant, and all of them was found to be haploid with 24 chromosomes. The low chromosome number permitted

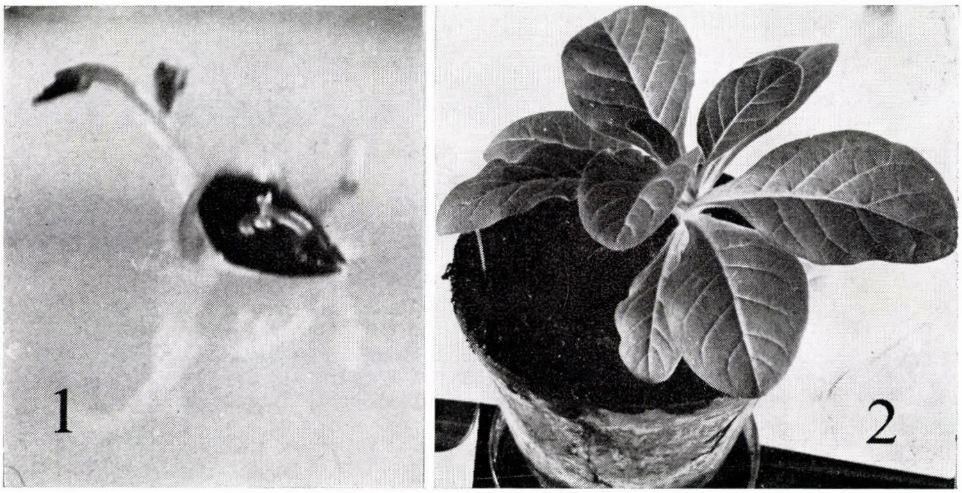
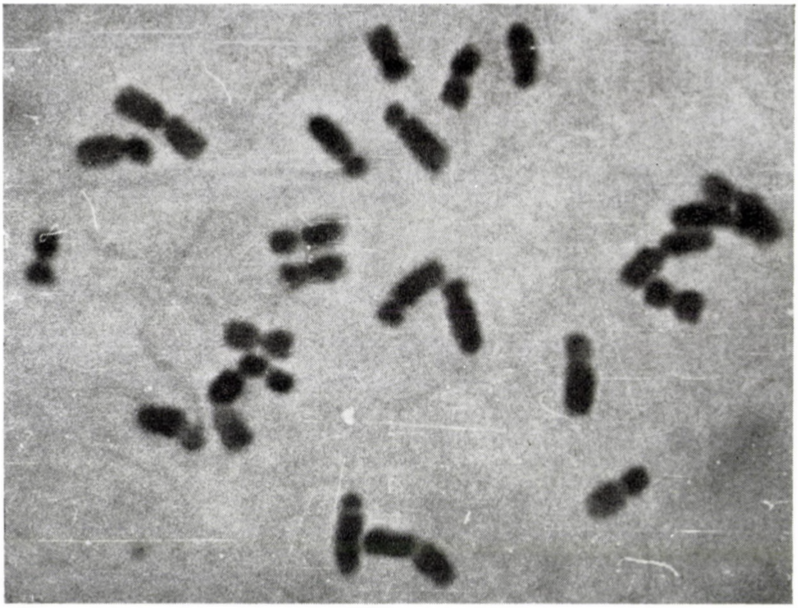


Fig. 1. Anthere culture with haploid plant
Fig. 2. Haploid plant of *N. tabacum* (Ky) × *N. glauca* alloploid hybrid (n=24)

karyotype construction relatively easily (Fig. 3). There are 4 metacentrics, 4 submetacentrics and 16 acrocentrics in each cell.

Polypeptide spectra of the "haploid" and "diploid" *N. tabacum* × *N. glauca* hybrids in SDS electrophoresis proved to be virtually identical (Fig. 4).



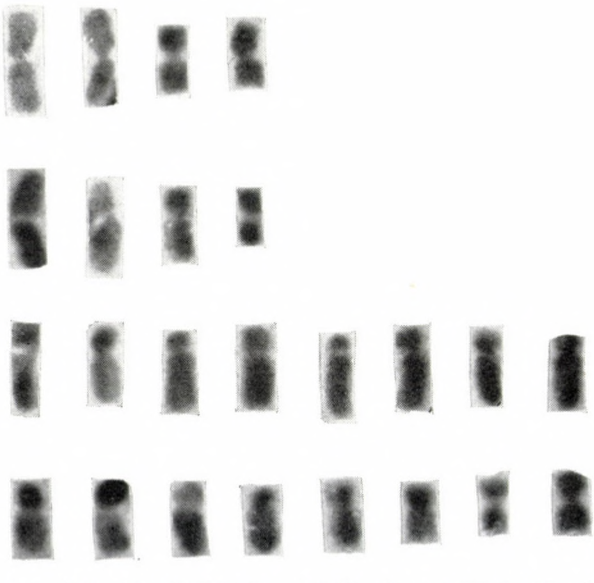


Fig. 3. Karyotype of the "haploid" plant of *N. tabacum* (Ky) × *N. glauca* alloploid hybrid ×1000

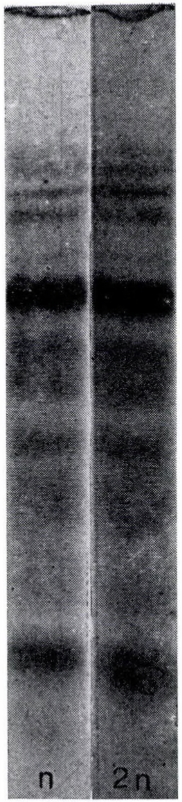


Fig. 4. Soluble protein composition of the leaves of haploid and diploid *N. tabacum* × *N. glauca* alloploid hybrid plants

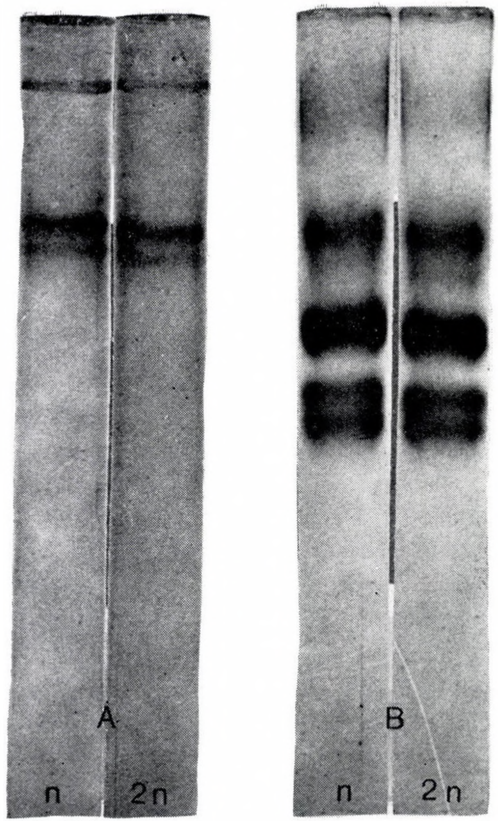


Fig. 5. Phosphodiesterase (A) and esterase (B) isoenzymes of the leaves of haploid and diploid *N. tabacum* × *N. glauca* alloploid hybrid plants

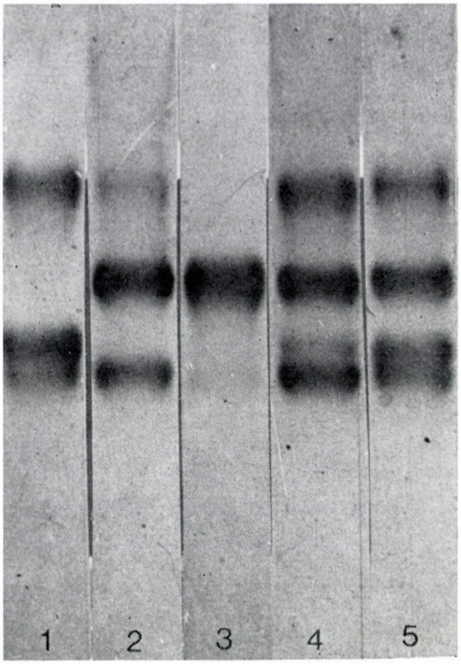


Fig. 6. Esterase isoenzymes of the leaves of alloploid hybrids and those of its parents lines 1. *N. sylvestris*; 2. *N. tabacum* (Kentucky); 3. *N. glauca*; 4. *N. tabacum* × *N. glauca* (2n=72); 5. *N. tabacum* × *N. glauca* (2n=48)

We could not detect any difference in quantity and quality of the polypeptides. Similarly, 3 phosphodiesterases and 4 dark and a single faint line of esterases were found in leaves of both haploid and diploid plants (Fig. 5).

Esterase isoenzyme patterns of the alloploid hybrids and those of its parents are shown in Fig. 6. Out of the 3 isoenzymes of both *N. sylvestris* and *N. tabacum* 2 are identical and one is specific to each species.

N. glauca exhibits a darkly staining band also present in *N. tabacum*. In the alloploid hybrid of *N. tabacum* × *N. glauca* there is an additional band which has not been found in *N. glauca* or *N. tabacum* but clearly observable in *N. sylvestris*. This band is more intense in the hybrid derivate (2n=48) than in the original *N. tabacum* × *N. glauca* 2n=72 hybrid as revealed by the densitogram (Fig. 7).

Discussion

Successful haploidization was achieved with anthere culture of alloploid Nicotiana hybrid. The chromosome number was found to be 24 as compared with the original 2n=48. *Nicotiana tabacum* itself is known to be alloploid, apparently originated from a hybrid of *N. sylvestris* and *N. tomentosiformis*

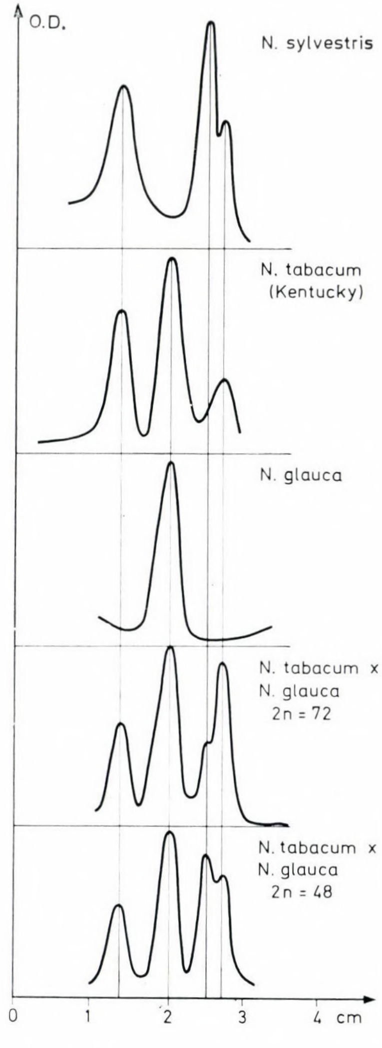


Fig. 7. Densitograms of esterase isoenzymes shown in Fig. 6

(GOODSPEED and CLAUSEN 1928). Our *N. tabacum* $\times$ *N. glauca* hybrid derivate might therefore contain 3 kinds of genomes. According to isozyme studies the hybrid does not contain all the isozymes of *N. sylvestris* esterases. This is not surprising, since interactions of the genomes may result in new subunit combinations and/or modifications of gene expression by means of regulatory differences.

It is noteworthy, however, that as a result of hybridization and chromosome elimination in the line of *N. tabacum* $\times$ *N. glauca* hybrid an isozyme band

characteristic of *N. sylvestris* is observable again. A possible explanation to this remarkable feature is, that the activity of this *N. sylvestris* gene was suppressed by certain gene(s) of the other genome (*N. tomentosiformis*) in the originally also alloploid *N. tabacum*. The decreased proportion or partial elimination of the suppressing genome made possible the reexpression of this previously "silent" gene(s).

Cytological analysis of the hybrid derivate seems to support this hypothesis. Chromosomes of *N. glauca* have been retained during the subsequent generations, while elimination of chromosomes were shared by both *N. sylvestris* and *N. tomentosiformis* genomes.

All the plantlets obtained by anthere culture in our experiment were "haploid". (The word "haploid" refers here to the reduced level of chromosomes, in fact, in this case it contains three genomes in different proportions.) Meiotic analysis of these plants may cast some light on the homologies of the genomes involved and on the problem of base number and evolution of the genus *Nicotiana*.

The alloploid, as expected, shows regular meiotic pairing. This is reflected in the isozyme studies as well. Each "haploid" plantlets showed the same pattern and intensity of enzyme and protein spectra.

Each enzyme studied in our experiment has previously been reported to be gene-dose dependent, although in leaves of other species. CARLSON (1972) was able to localize some structural genes on this basis in trisomic lines. Activity levels of peroxidases and phosphodiesterases of other plants were found to be controlled by the number of structural and regulatory genes, moreover cytoplasmic effect was also detectable in recipiae crosses (WOLF and RIMPAU 1977, WOLF and LERCH 1974, DEMAGGIO and LAMBRUKOS 1974). Since in our experiment there can be no doubt concerning gene dose differencies (haploid and diploid plants), yet the isozyme and protein spectra appear to be identical both qualitatively and quantitatively, we regard dose relationships of structural and regulatory genes to be of utmost importance. On the other hand, the electrophoretic results of haploid plants prove, that in the meiosis of diploid (2n=48) plant autosyndetic bivalents are formed and distributed equally in the pollen tetrad.

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THE ALKALOID PRODUCTION IN DATURA INNOXIA TISSUE CULTURES

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Root and stem callus tissue cultures were cultivated on MURASHIGE-SKOOG solid culture-media, under 2500 Lux, and in dark. It was found that the alkaloid content of the cultures cultivated in light was higher. However, the amount of alkaloid is essentially smaller in all the tissue cultures (two years old) than that in the initial material. The non-esterified and the nor-compounds are to be found in a more significant quantity. The direct precursors of the amino-acids are present only in traces. The incorporation of $3^{14}C$ phenyl-alanine causes inhibition in the formation of alkaloid, while $2^{14}C$ Na-acetate increases the alkaloid content.

Introduction

The role of medicines of plant origin in therapy and in pharmaceutical industry is very important. Since the growing of plants requires an area of soil and, besides, it depends on many other factors — for example, on weather, precipitation, temperature and light conditions — experiments are being carried out to ensure the materials of natural origin not only by organic chemistry synthesis but also by biological methods, by means of the so-called biological production. Therefore, the production of plant tissue cultures, the sterile cultivation of plant cells, tissues and organs have become very wide-spread in the last two decades. Theoretically, the study of plant tissue cultures helps to elucidate plant metabolism, for example, the biosynthetic paths, and to clarify relations between morphogenetics and secondary metabolism. Further, it provides experimentally reproducible data for the recognition of fermentation processes which have gained ground in the pharmaceutical industrial production of agents of natural origin, as for example the production of antibiotics.

Studying the tissue cultures of *Datura* species is directed towards the following viewpoints:

1. exploration of the characteristics of tissue culture cells and tissues;
2. research on the influence of various factors in relation to the development of cultures and of the changes in contents;
3. detecting of the alkaloid content and composition;
4. biosynthetical examinations, etc.

The aim of our work was to study the alkaloid production and composition of the *Datura innoxia* tissue culture produced by us, furthermore, to obtain data on the alkaloid biosynthesis of tissue cultures in an experimental way.

Material and method

For the tissue culture a modified solid culture-medium of MURASHIGE—SKOOG (MARÓTI 1976) was used. Kinetine, 2,4-D (mg/liter) (=2,4-Dichloro-phenoxy-acetic acid), agar-agar

(8 g/liter) and also nicotin acid (0.5 mg/liter) as well as pyridoxine-HCl (0.1 mg/liter) were added to the culture-medium, pH was set at 6.

1. Induction and grafting of the plant material

For inducting the callus, sterilized pieces of leaf, or root of the *Datura innoxia* Mill. plants were used.

2. Method of sterilization of the various plant parts

The various organs were washed with detergents and water current; they were treated with 70% ethanol for one minute, then with the solution of diacid (ethanolmercury-chloride + + methyl-pyridine-chloride) (BUTENKO 1964), and flushed with sterile distilled water. The culture-media was sterilized at 0.8 atm pressure for 2×15 minutes.

The callus tissues were grown in test-tubes containing 40 ml of culture-media, and were grafted into fresh culture-medium at six week intervals. HIRAOKA and TABATA (1974) dealt with the stem-culture and suspension-culture of *Datura innoxia* Mill., we on the other hand with callus-cultures prepared from leaves and roots in the following conditions:

leaf tissue culture	26 °C,	in light (2500 Lux)
leaf tissue culture	26 °C,	in dark
root tissue culture	26 °C,	in light (2500 Lux)
root tissue culture	26 °C,	in dark

The callus tissues and their culture-media were processed according to the following method:

3. Extraction and purification of alkaloids from tissue cultures and their culture-media

The tissue cultures were separated from the culture-media, then both the media and the tissue cultures were lyophilized. For extraction, MeOH—28% NH_4OH (9 : 1) was added to it, was left at night then was extracted with chloroform for 6 hours, in a SOXHLET apparatus. The extract which contained chloroform was evaporated under vacuum. The remaining material was again taken into, about 30 ml, chloroform and the alkaloids were eluted into 2×20 ml of H_2SO_4; after with cc. ammonia to pH = 9, the material was shaken out with 30 ml chloroform; this was repeated three times. The solution was then filtered through water-free sodiumsulphate and the solvent was evaporated. The remaining material was diluted in 10 ml of p.a. $CHCl_3$ and this solution was used for various analyses. Occasionally, fresh tissues were also processed, destroyed with quartz sand and extracted in the above way.

4. Quantitative and qualitative determination of the alkaloids

a) For the quantitative determination of tropane alkaloids we used partly the method which has been described in the Sixth Hungarian Pharmacopoeia (that is, titration in water-free medium), partly another more sensitive method by using a tropeline amphi-indicator (LŐRINCZ and SZÁSZ 1961).

For standard series, scopolamine base was used (FLUKA A. G., BUCHS). By diluting the material in sulphuric acid, we prepared a stock solution containing 100 μg/ml scopolamine. The measurements were carried out with SPECTROMOM 202 photometer, in cuvettes of 1 cm dia, at wavelength of 496 nm. As control we used chloroform and tropeolin solution.

b) For the qualitative determination, the following methods were used:

1. Thin-layer chromatography (VERZÁR-PETRI, SÓTI and HORVÁTH 1974);
2. Gas chromatography (VERZÁR-PETRI and HAGGAG 1976);
3. Autoradiography (VERZÁR-PETRI 1969).

5. Isolation and determination of the amino-acids

a) 1 g of lyophilized tissue culture was destroyed with seasand, then 50 ml of warm 70% ethanol was added. The material was stirred, then left for 30 minutes; it was filtered and the filtrate extracted with 3×50 ml of chloroform. The chloroformic extraction contained the bound amino-acid, while the ethaurké phase hold the free amino-acides.

The chloroformic extraction was evaporated for lyophilization, the remaining material was transferred into 15 ml ampules; 10 ml of 6N (Merck Art 317) HCl was added. The ampules were closed under normal conditions, then were hydrolized at 105 °C for 24 hours.

The content of the ampules was quantitatively washed in a 10 ml-flask, then the material was evaporated for lyophilization, under high vacuum. The remaining material was re-diluted in 20—25 ml of water and evaporated again. The sample prepared in this way was collected in 0.2N NaCl 0.01 HCl and in this medium placed on the amino-acid analyser. A JEOL JLC-5AH-type amino-acid analyser was used for the analysis. It was set to the bi-columnar method, controlled by an automatic programme.

The spherical resin manufactured by the firm JEOL under the trademark LC-R_1 phantasy name was used for the analysis.

The characteristics of the eluate:

a) 0.20N Na pH 3.25
b) 0.20N pH 4.25
c) 0.35N pH 5.28
(Sodium citrate, HCl, n. capric acid, thiodiglycol, Brij-35, methanol)

For the preparation of the solutions, bidistilled water de-ionized on Elgastat resin was used.

Reagent: Merck Art 6762 ninhydrin diluted in acetate buffer and Merck Art 859 (2%), which was prepared under nitrogen current and also its application took place under nitrogen tension. The chromatographs were evaluated according to the HW method (peak height: width).

6. Isotopic experiment for studying the changes in the alkaloid content of the tissue

Two-year-old root callus cultures were separated from the culture-media and put in separately into solutions containing radioactive materials. The tissue culture was kept in a thermostat at 25 °C in dark or under a fluorescent lamp (2500 Lux). At certain times (one hour, 24 hours, 48 hours) part of the incubated tissue culture was taken out, washed immediately in distilled water; either after lyophilization or immediately, the alkaloid extraction was carried out according to the procedure described above.

Preparation of the radioactive solution

The specific radioactivity 2 ^{14}C Na-acetate: 28.62 μCi/mg, 17.051 mg of 2 ^{14}C Na-acetate was measured and dissolved with 0.487 mCi activity and 100 ml distilled water. This solution was used for incubation.

Phenylalanine: the specific radioactivity of 3 ^{14}C: 13.64 μCi/mg; 45.38 mg was measured with 0.618 mCi activity; it was dissolved in 100 ml distilled water and this solution was used for the incubation of the tissue culture.

Experimental results and their discussion

1. Alkaloid content and composition

The total alkaloid content of the intact plant is always higher than that of the tissue cultures let it be a tissue culture originating from any organ (germ, leaf, stem, root, bark, etc.). According to the publications so far, the alkaloid content in tissue cultures amounts on the average to 0.0041—0.042%; CHAN and STABA (1965) hold the view that there is no significant relation between

the alkaloid content of intact tissues and that of the tissue cultures originating from them. The case is rather that after grafting the new tissues forming during the cultivation are able to synthesise alkaloids, and this characteristic in a final analysis is genetically given. Apparently, however, in the case of tissue cultures, plasmatic inheritance and regulation also play a part in the changes of alkaloid production. CHAN and STABA (1965) obtained such values of the *Datura stramonium* culture (5.5 month old) the alkaloid content of which varied between 0.004—0.056%. NETIEN and COMBET (1966) [cited from HIRAOKA's work (1976)] found that the alkaloid content of the one-year-old stem-callus of *D. metel* was about 0.0056% (related to fresh weight). ROMEIKE and KOBLITZ (1970) reported that the alkaloid contents of the callus of *D. stramonium* (5 years old), and of the stem-callus of *D. metel* (19 months old) amounted to about 0.0026% and 0.00185%, resp. KRIKORIAN and STEWARD (1969) were not able to detect the tropane alkaloids in the tissue cultures of the various *Datura* species.

In our experiments, the following results were obtained:

Table 1

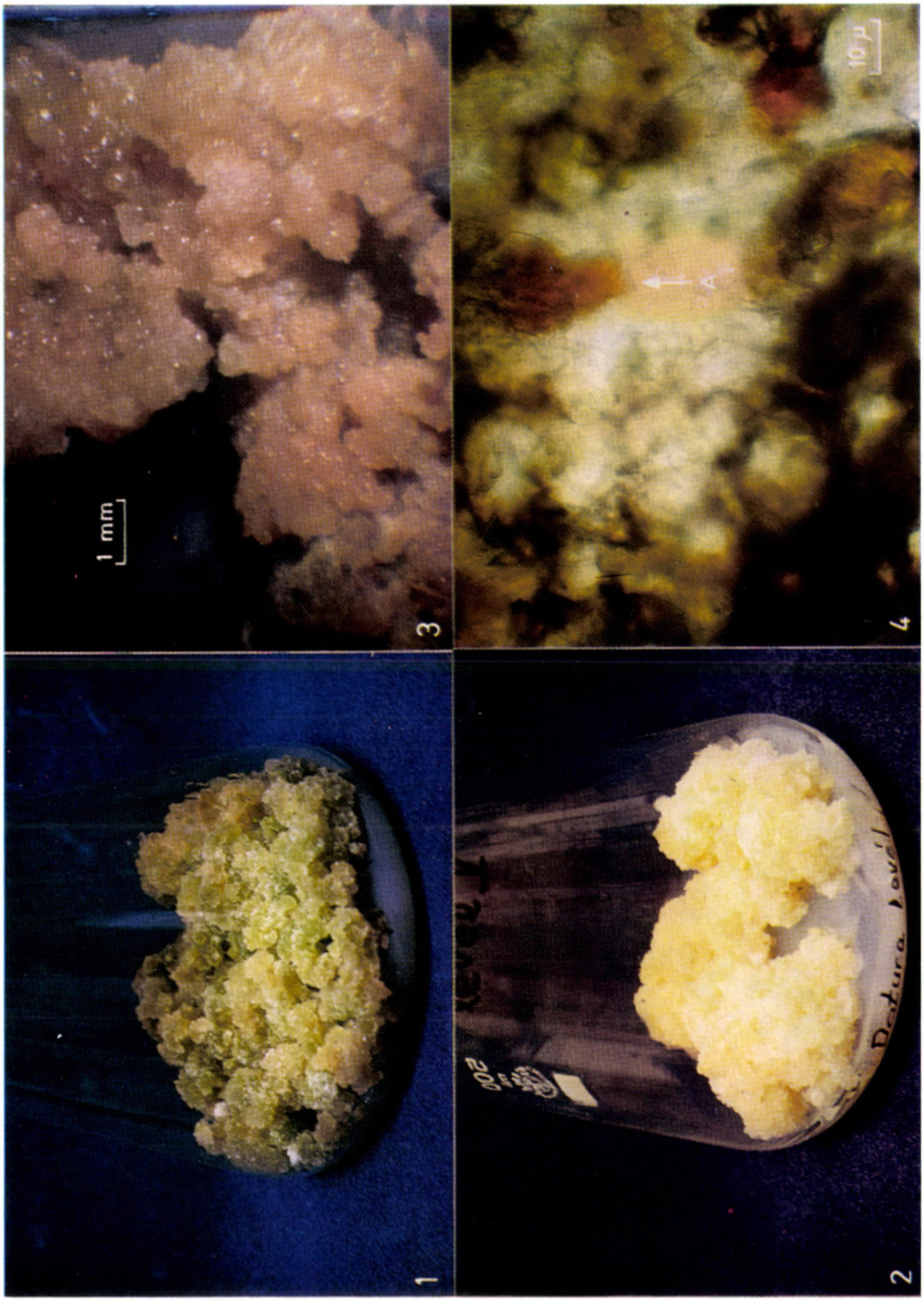
The alkaloid content of Datura innoxia tissue cultures used in our experiments

Designation and conditions of growth	The alkaloid content of tissue cultures, related to dry weight %	The alkaloid content of intact organ, %	The alkaloid production of the tissue culture in relation to the intact organ
Root culture cultivated in light	0.0390	0.33	10 times lower
Leaf culture cultivated in light	0.0226	0.25	10 times lower
Root culture cultivated in dark	0.015	0.33	20 times lower
Leaf culture cultivated in dark	0.0075	0.25	30 times lower

Their culture-media also shows a positive alkaloid reaction (with DRAGENDORFF reagent)' but the quantity could not be determined because it was insignificantly small.

See also Figs 1, 2, 3 and 4.

Fig. 1. Leaf tissue culture (1 year old) of *Datura innoxia* Mill. cultivated in light intensity of 2500 Lux
Fig. 2. Leaf tissue culture (1 year old) of *Datura innoxia* Mill. cultivated in dark
Fig. 3. Root tissue culture of *Datura innoxia* Mill. cultivated in dark
Fig. 4. Histochemical reaction of alkaloids (A) in leaf tissue culture of *Datura innoxia* Mill. proved by DRAGENDORFF reagent. Light microscopical picture


1
2
3
1 mm
4
10 μ
A

Our qualitative observations related to the alkaloid spectrum were as given below (see also VERZÁR-PETRI, KIET and SZŐKE 1977; and Figs 5 and 6).

In the leaf tissue culture of *Datura innoxia* Mill. cultivated in light, 8 alkaloids were determined: cuscohygrine, meteloidine, teloidine, hyoscyamine, 3-6 ditigloiloxytropane, scopolamine, 6-OH hyascyamine and nor-scopolamine; besides, a great quantity of tropine and tropic acid was found, in free, non-esterified form, together with 2 unknown peaks on the gas-chromatogram, which occured at 220 °C and 226 °C.

It is worth note that in leaf cultures the quantity of scopolamine is smaller than that of hyoscyamine whereas the plant itself is a scopolamine main alkaloidal species and it is commonly known that epoxidation takes place in the leaf tissues. Hyoscyamine 6-OH, incidentally indicating the process, is also present, and even demethylizing enzymes are in operation; the nor-scopolamine is also detectable. The same number of components was found in the culture-media but only in a very small quantity.

In the root tissue culture of *D. innoxia* Mill. cultivated in dark, tropine and tropane acid occur in smaller amounts but 6-OH hyoscyamine and cusco-

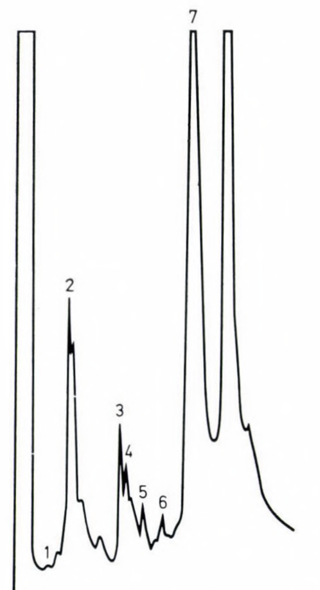


Fig. 5. Control gas chromatogram of alkaloid extract from roots of developed *Datura innoxia* Mill. plants. 1. tropine, 2. cuscohygrine, 3. meteloidine, 4. tropic acid, 5. teloidine, 6. hyoscyamine, 7. scopolamine

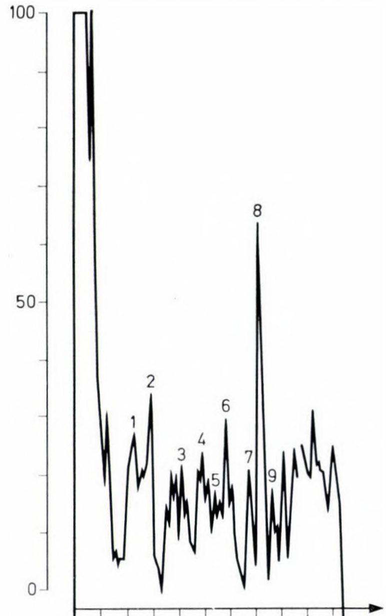


Fig. 6. Gas chromatogram of alkaloids in *Datura innoxia* Mill. root tissue culture cultivated in dark. 1. tropine, 2. cuscohygrine, 3. meteloidine, 4. tropic acid, 5. teloidine, 6. hyoscyamine, 7. scopolamine, 8. 6-OH hyoscyamine, 9. nor-scopolamine

hygrine — the intermedier alkaloid of tropane-alkaloid biosynthesis — dominate in the tissue culture. The quantity of the scopolamine is more than that of hyoscyamine, a reversed case of the leaf tissue culture; their ratio is similar to that of the intact root (see Figs 5 and 6). In our judgement, which is confirmed by our earlier isotopic examinations (VERZÁR-PETRI et al., 1974), the appearance of 6-OH hyoscyamine is a sign of the scopolamine biosynthesis since it is a compound always present in the interconversion of hyoscyamine and scopolamine, while the cuscohygrine is a characteristic alkaloid of the root, which — according to our own observations — is the first to appear on germination by the formation of the young radicule (VERZÁR-PETRI and KIET 1977). The quantity of the alkaloids present in the culture-medium, as mentioned above, was insignificantly small (see Table 2).

Table 2

The amino-acids occurring in Datura innoxia Mill. intact plants and tissue cultures

Amino-acids	Root tissue cultures**		Leaf tissue cultures**		Intact plant*	
	Cultivated in light	Cultivated in dark	Cultivated in light	Cultivated in dark	Root	Leaf
Asparatic acid					++	++
Asparagine	++	+	+++	++	+	+
Glutamic acid	+	—	+		+++	++
Glutamine	+++	+	+++	++		++
Alanine	++	+	++	—	+++	++++
Serine	++	—	+++	+	+++	+++
Proline***	—	—	+	—	++	++
Valine	++	+	+++	+	++	+
Threonine	+		+	±	—	±
Leucine+isoleucine***	++	+	++	+	++	++
Tryptophane	+	—	—	—	+	++
Tyrosine	—	—	+	—	±	±
Phenylalanine***	+	+	+++	+	++	+
Glycine	++	—	++	—	+++	+++
— aminobutyrinic acid	—	—	+	—	—	—
Lysine	—	—	—+	—	+	++
Arginine	++	—	++	—	++	++
Ornithine***	—	—	—	—	++	++
Histidine	+	—	++	—	—	—
Methionine	+	—	++	—	—	—

* According to VERZÁR-PETRI.
** In determing the alkaloids, the "Full Automatic Amino Acid Analyzer TLC-5AH" apparatus was used.
*** Alkaloid precursor amino-acid.

Table 3

The relative quantity of alkaloids in the Datura innoxia Mill. tissue cultures, on the basis of gas chromatography

Alkaloid component / Tissue culture type	A	B	C	D	E	F	G	H	J	K
Leaf tissue culture (Cultivated in light)	5	2	3	5	3	2	3	1	2	2
Culture-medium of leaf tissue culture (Cultivated in light)	1	2	2	2	1	2	2	3	1	2
Leaf tissue culture (Cultivated in dark)	—	1	3	2	2	3	2	4	2	—
Root tissue culture (Cultivated in light)	—	2	3	1	3	5	4	4	5	4
Root tissue culture (Cultivated in dark)	3	4	2	3	1	3	—	2	4	2
Culture-medium of root tissue culture (Cultivated in dark)	1	2	2	1	—	1	2	1	2	2

A: tropine, B: cuscohygrine, C: meteloidine, D: tropic-acid, E: teloidine, F: hyoscyamine, G: ditigloyloxytropane, H: scopolamine, J: 6 OH-hyoscyamine, K: nor-scopolamine.

Table 4

Changes in the alkaloid content of the Datura innoxia Mill. tissue cultures, during the incubation with various radioactive precursores

Type of alkaloid / Experimental material	A	B	C	D	E	F	G	H	J	K
Control	4	2	3	5	3	3	3	2	3	2
I*	2	2	4	3	2	4	2	4	2	5
II	—	1	2	2	2	3	2	4	5	4
III	2	3	1	3	1	2	4	—	2	2
IV	—	1	1	2	1	—	4	—	3	3

I: D. i. leaf tissue culture cultivated in light; 24 hours' incubation with $2^{14}C$ Na-acetate.

II: D. i. leaf tissue culture cultivated in light; 48 hours' incubation, with $2^{14}C$ Na-acetate.

III: D. i. root tissue culture cultivated in light; 1 hour's incubation, with $3^{14}C$ phenylalanine.

IV: D. i. root tissue culture cultivated in light; 24 hours' incubation, with $3^{14}C$ phenylalanine.

2. *Alkaloid precursors*

— (A) The amino-acid composition of the tissue-culture

The amino-acids occurring in various parts of *Datura stramonium* L., *D. meteloides* and *D. innoxia* Mill. plants have already been examined in detail (Verzár-Petri 1966). There are 16 amino-acids which are detectable in the intact tissue. In the stem-culture of the *D. stramonium* var. *tatula* there were only a few amino-acids described.

The amino-acid occurring in the leaf and root tissue cultures or culture media of *Datura innoxia* Mill. cultivated in dark and in light was examined and the following results were obtained (see Table 2 and Fig. 9):

On the basis of the investigations, it could be inferred that, independently of the organ, the amino-acid spectrum and content of the tissue cultures cultivated in light is richer.

—(B) Incorporation of $2^{14}C$ Na-acetate and of $3^{14}C$ phenylalanine into the alkaloid spectrum of the *Datura innoxia* tissue culture

The aim of the investigations was to detect the influence of $2^{14}C$ Na-acetate and of $3^{14}C$ L-phenylalanine on the changes in the alkaloid content in the root and leaf tissue culture of *Datura innoxia*, and to determine the alkaloids into which these precursors are incorporated during the incubation time of 24 hours and 48 hours.

On the basis of the results obtained, the following inferences can be made (see Table 4; Figs 7 and 8).

a) *In the experiments carried out with $3^{14}C$ phenylalanine*: in comparison with the control, the total alkaloid content of the culture decreased during the incubation time of 24 hours and it became so small that we were not able to determine it with the general method of investigation. On the basis of the integral data of gas-chromatography and of the size of the area below the peak, we noticed that the quantity of tropine (tropanol) was rather high in the control tissue culture. On incubating for one hour, it decreased: and after 24 hours it altogether disappeared. Tropic acid also decreased rapidly after the 24 hours incubation. Specific radioactivity was very small, and specific incorporation was 0.0002%. This result testifies to the fact that no new tropic-acid was formed in the tissue culture, and in this case the presence of phenylalanine is an obstacle in the biosynthesis of tropic acid. The synthesis between hyoscyamine and scopolamine did not take place either. Scopolamine di-

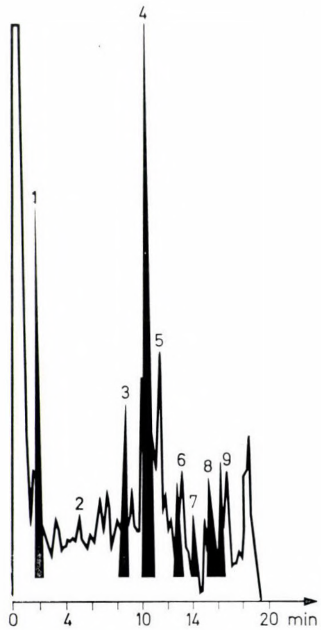


Fig. 7. Gas chromatogram of the alkaloids extracted from *Datura innoxia* Mill. leaf tissue culture cultivated in light. 1. tropine, 2. cuscohygrine, 3. meteloidine, 4. tropic acid, 5. teloidine, 6. hyoscyamine, 7. scopolamine, 8. 6-OH hyoscyamine, 9. nor-scopolamine

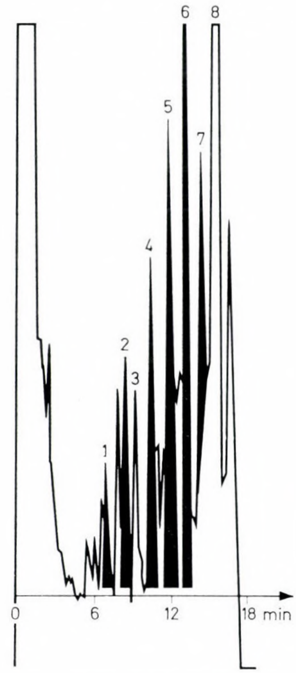


Fig. 8. Gas chromatogram of alkaloids extracted from *Datura innoxia* Mill. leaf tissue culture cultivated in light, after a treatment of 48 hours' incubation with 2 ^{14}C Na-acetate. 1. meteloidine, 2. tropic acid, 3. teloidine, 4. hyoscyamine, 5. ditigloyloxytropane, 6. scopolamine, 7. 6-OH hyoscyamine, 8. nor-scopolamine

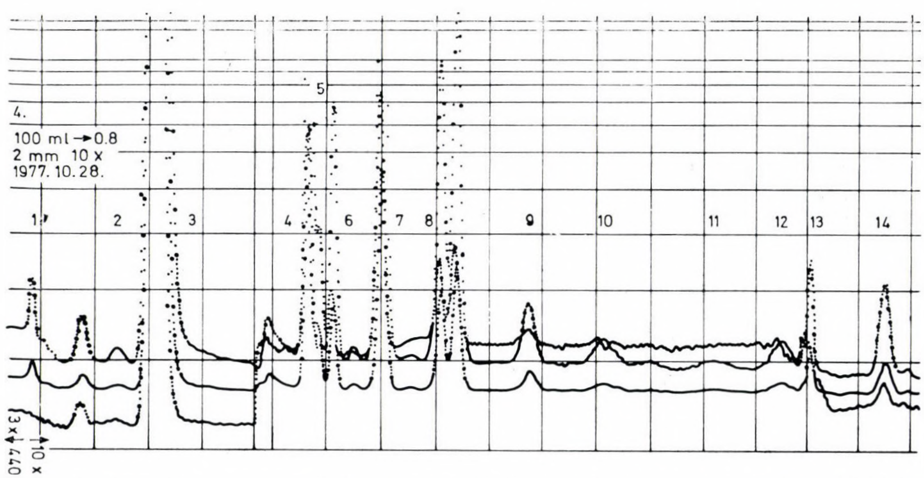


Fig. 9. Amino-acid spectrum of *Datura innoxia* Mill. leaf tissue culture cultivated in light (determined by using of Full Automatic Amino Acid Analyzen TLC—5AH apparatus).
1. lysine, 2. histidine, 3. ammoniac, 4. asparagine, 5. threonine, 6. serine, 7. glutamine, 8. alanine, 9. valine, 10. methionine, 11. isoleucine, 12. leucine, 13. tyrosine, 14. phenylalanine

appeared altogether on the gas-chromatogram, after the incubation times of 1 hour and 24 hours; hyoscyamine also disappeared after a smaller decrease following a 24 hours' incubation. In such cases, according to HIRAOKA (1976), ROMEIKE and KOBLITZ (1972), the tissue culture used up the tropine for the biosynthesis of acetyltropine. Meteloidine and especially the ditigloyloxytropane can be found and are well-detectable in the cultures incubated for 1 and 24 hours. It seems that their biosynthesis is not hindered in the presence of phenylalanine, since the acid part of these alkaloids is not tropic acid, but tiglic acid.

b) *In the experiments carried out with* $2^{14}C$ *Na-acetate*:

According to the results obtained, Na-acetate increases the alkaloid formation in *D. innoxia* tissue cultures. The pattern of the total alkaloid content during the incubation is as follows (related to dry weight):

Control	= 0.0226%
24-hours' incubation, leaf culture	= 0.0483%
48-hours' incubation, leaf tissue culture	= 0.025%

The individual alkaloids also vary during the incubation: on incubating for 24 hours, the quantity of almost all the alkaloids, with the exception of tropine and tropic acid, increased. On incubating for 48 hours: with the exception of 6-OH hyoscyamine, the quantity of all the alkaloids decreased, that of hyoscyamine and scopolamine also decreased but compared to the control it was still higher. Their specific radioactivity (dpm/mM):

	24-h incubation	48-h incubation
Ditigloyloxytropane	766.341.29	792.372.20
Scopolamine	501.314.64	346.295.44
Hyoscyamine	230.047.30	159.868.91

The specific radioactivity of ditigloyloxytropane was the highest. This observation is in agreement with the pattern of alkaloid content of Datura innoxia root the nutrient of which was 2^{14}Na-acetate (VERZÁR-PETRI et al. 1974, 1977), that is, the radioactive sodium-acetate was incorporated first of all into the tigloyl ester alkaloids which then remained either in this form or transformed into another product.

By summing up the results of the two experiments carried out by us (in adult plants and in tissue cultures obtained from them), it can be supposed that from the sodium-acetate leucine, — isoleucine was formed first, and in the following step tiglic acid forms from isoleucine; the original tiglic acid forms an ester with the tropine and results in the tigloylester alkaloid. This process may take place earlier than that of the structure formation, both in the intact plant and the tissue culture.

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RECENSIONES

ARNOLD, G. W.—de WIT, C. T.: Critical evaluation of systems analysis in ecosystems research and management. PUDOC, Wageningen. 108 pp, 1976.

This book edited by de WIT and ARNOLD is the 8th volume in a continuing series titled "Simulation Monographs". This series introduces the readers stepwise to some of the main aspects of system ecology. The titles of previous volumes of this series are listed in this book as well.

The book contains a collection of some papers presented at the 1st International Congress of Ecology on "Critical evaluation of systems analysis and modelling in ecosystems research and management" held at the Hague in September, 1974. This symposium organized by de WIT and GOODALL aroused considerable interest, because a lot of mathematical models in ecology have been used recently, but there is a great, frequent confusion especially with respect to the validity of models even now.

It is only in the last decade that many biologists have applied the systems analysis approach to their problems. Several symposia and innumerable books on special modelling problems as well as the theory and the use of ecosystem analysis have been held and published so far.

So the themes presented in the book are not unknown, but their discussions are useful, because the papers contain the newest results in this field as well as critical reviews of many problems.

This is why the organisers considered publishing some relevant papers delivered at the congress together with some other articles on the same subject.

This book will be of interest to all those concerned with the problems of modelling as well as to graduate students.

The book consists of 7 papers including several figures and bibliography.

In the first paper some of the problems of ecosystem modelling are introduced by de WIT and ARNOLD. A few common concepts, as model, system and simulation are defined briefly and some of the main aspects of system ecology and building of models are mentioned.

It is emphasized, that we should limit our goals, and focus attention only on certain aspects in constructing a model for complicated systems.

In the authors' opinion the simulation model may be a good aid for understanding important aspects of systems, but it is also pointed out that biologists should apply some principles more rigorously. The 5 principles proposed by WIGAN (1972) are: postulates, fitting, calibration, identification and validation, which are also explained concisely and regarded as a useful methodology in minimizing internal errors and maximizing the validity of a model.

GOODALL's paper discusses how to use the hierarchical approach to model building.

Complexity, the interrelations among a large number of components in any system are almost beyond the power of direct thought, so it is very important for all modellers to divide a system into sub-systems. It can greatly facilitate the modelling process and the study of the behaviour of the system. Decomposition of systems is also advantageous, because the subsystems may be described and tested separately as well as at different levels of complexity.

GOODALL also points out that "a hierarchical approach alone may not be the most appropriate method for breaking down an ecosystem". That's why he emphasizes application of the method of cross-classification in addition to a strict hierarchy of sub-models. This method can be regarded as a new, valuable and useful one in the field of model building.

An actual model based on a hierarchical structure of sub-models and principles of cross-classifications is demonstrated by GOODALL in detail. The model constructed is applied on an area of savannah woodland in Queensland in Australia grazed by cattle and wallabies in order to predict the mean rate of gain in weight by the cattle over the whole year.

KEULEN in his paper writes about evaluation of models. It is already commonplace, that the biological systems are more complicated than with which mathematicians and physicists work and the representation and verification of models constructed for living systems are more difficult. In the past 30 years innumerable models for ecological systems have been made and used, but it is a great pity, that little attention has been paid to the critical evaluation of these models so far.

KEULEN deals with the problems of validity of models and with the most important decisions (e.g. the objectives, the boundaries of the model and the processes incorporated in the model), which the modellers must take to build apply and test a model.

JAMESON in his article "Management of ecosystems: information supplied by simulation models" offers the use of generalized models of grassland ecosystems, which can provide a method of getting enough information to make good grassland resource and management decisions.

He analyses three major attributes of biome type research in detail. JAMESON describes the problems and the advantage of applying "state variable" measurements and studying processes in the modelling. He also draws up a model in broad lines, which was developed by BARTLETT, EVANS and BEMENT (1974) and was built upon a linear programming model including also the seasonal growth of vegetation and change of livestock.

JAMESON states, that a simulation model appropriately constructed may be used to generalize the results obtained in certain circumstances for years and other places.

An other way of using modelling ecosystems is introduced by MILLER and MOONEY.

Their detailed investigations carried out in two Mediterranean shrub areas in California and Chile are presented in their paper. The areas can be characterized by broadly similar climates and similar vegetation forms, but by different genetic histories.

To explain the degree of both the similarity and dissimilarity of vegetation forms and functions in the 2 areas, the interactions between primary productions, microclimate and plant growth were studied. A model based on mathematical, physical and physiological processes also was formulated to analyse some of the interrelations between climate and form and function of the vegetation, as well as to assume the divergence factors leading to the convergence of form and function from different genetic stocks.

The results of simulation models and a lot of other investigations are very valuable. So for example water-use and photosynthetic efficiency as well as productive period of evergreen shrubs in California and Chile are investigated in details and the importance of the length of the productive period for the existence of different plant life forms are also determined.

SELIGMAN is his article provides a thorough discussion on several grassland models constructed in the last decade and critically reviews some of them.

First he gives a short account of the present state of modelling and the increasing problems.

SELIGMAN quotes PATTEN's (1970), de WIT's (1970) and ARNOLD'—BENNETT's (1975) opinion about the application and usefulness of biological system models.

He shows a simple model with respect to some relationships between variables in a grassland system. This model can be used by the modellers interested in pasture, animal and management interactions.

Then SELIGMAN gives a list of some newest crop, grassland and ecosystem models, which have been selected to represent different levels of complexity and different approaches to the analysis of grassland systems.

To mention some of them:

Basic crop simulator (BACROS; de WIT et al. 1970, 1976) is a physiological process model, which simulates the photosynthesis and distribution of assimilates between shoot, root and respiration of specific crop canopies. The SPAM (Soil Plant Atmosphere Model; LEMON et al. 1971, STEWARD and LEMON 1969) and the Arid Crop models are similar to BACROS, but they are more comprehensive applied models than the basic BACROS is.

SELIGMAN deals with several grassland models in detail. Some important ones mentioned by him are LEYFARM and PASTOR models.

LEXFARM (ARNOLD—CAMPELL 1972, ARNOLD et al. 1974) is used for simulating grazed, annual (legume) pasture from seed germination through growth, flowering, seed formation, death, decay and through grazing, which affect the pasture by reducing the living and dead biomass by consumption. The PASTOR model built up by GOODALL (1976) is a pasture management model.

It is very useful, that SELIGMAN presents the development of models step by step.

Finally, JEFFERS discusses the future prospects of systems analysisi n ecology. In his issue there is an interesting and useful meditation on the very broad application of good or fairly good models and on the basic criteria, which are needed for model construction and validation.

K. VIRÁGH

BRÜCHER, H.: Tropische Nutzpflanzen. Ursprung Evolution und Domestikation. SPRINGER Verlag, Berlin, Heidelberg, New York, 1977, 529 pp, 245 Abb. DM 248.—; US $ 109.20.

The increasing worries of feeding the Earth's population assign a rapid and effective increase of agricultural production as a growingly urgent task. It seems the conditions for this aim are mainly given in the tropical countries of the so-called "third world", where the possibilities are still great both by plant breeding and applying the modern achievements of agrotechniques. By all certainties it is a consequence of this circumstance that in the past years a number of books on tropical crops have been published. Some of them put as an aim to describe as many culture plants as possible, while others discussed only the most important ones with an endeavour, however to give a presentation of the plants by a many-sided and thorough-going approach comprising also the agrotechnical and plant-protectional methods which are to be applied to them.

The present book belongs to the first group, and in this category it is probably one of the most complete and most accurate works. The author is a specialist of plant breeding, who has acquired neotropical experiences of high level, and who has achieved considerable results also as an active genetic in the field of plant breeding and domestication of certain cultural plants (e.g. *Lupinus*, *Phaseolus*).

In a short, general introduction, the author makes two important statements. By placing the modern genetical and selectional aims of plant breeding in contrast with the natural selection of spontaneous mutants, he calls into doubt DARWIN's statement according to which the genesis of cultural plants is a model of evolution with respect to the whole kingdom of flowering plants. The author is undoubtedly right in that our yieldy culture variants of very low competitiveness and even of inability to reproduce themselves can much rather be considered as products of an "anti-evolution" than models of evolution. It must, however, be remarked also that probably even DARWIN himself — had he been in possession of the up-to-date storehouse and results of genetics — would not have formulated the criticised thesis. An even more important chain of thoughts is the one in which the author criticizes VAVILOV's gene-centre conception (pp 17—21), on the basis of partly his own neotropical examinations and partly the researchers of the Near-East "gene-centre" (HARLAN, HELBEAK, ZOHARY). The most important of his objections are as follows:

a) VAVILOV's montane gene centres are more appropriate to be considered as gene reserves than evolutionary centres;

b) there are numerous examples (*Oryza*, *Solanum*, *Lycopersicon*, *Ananas*) to prove that no homogeneous gene centres can be found and indeed the centres of origin and that of mutability of many taxonomical groups can occasionally occur even geographically very far from one another; finally;

c) the gene centre theory is completely inapplicable in the tropical areas of South-America; VAVILOV's gene centre No. VIII. is fully diffuse and inconfinable.

On the basis of the above arguments, BRÜCHER attacks VAVILOV's gene centre theory in its fundaments. We can agree with the author in that most of VAVILOV's gene centres would rather seem to be a domestication centre than a centre of evolution. It is also admittable that South-America is not a homogeneous gene centre and even its interpretation as an area is very questionable. It is not by mere chance that the present successes of agricultural genetics, and its possibilities appearing as almost unlimited, suggest the idea that VAVILOV's thesis should be interpreted by an approach from the opposite direction. Namely, it is not the gene centres of the cultural plants as economic bases where the ancient cultural centres of mankind have grown out from, but the other way round, the activity of domestication carried out in these culture centres has led to the forming of the denseness centres of culture plants. In this case VAVILOV's gene centres would be really secondary evolutionary centres induced anthropically, or more exactly domesticational gene centres. This debate can be settled only be means of further researches. In my feeling, however, the solution will lend itself not primarily from a plant geographical approach but the clarifying of the genetical past and present of the various culture plant groups may provide the explanation of the question.

There are seven chapters in the book; *viz.* (1) starch plants, (2) protein plants, (3) industrial plants, (4) fruit and vegetable plants, (5) spice- and drog plants, (6) oil crops and finally (7) palms as starch, oil and protein plants.

The origin, genetical conditions, taxonomical relations, description, conditions of domestication, importance and mode of using with respect to all the plants are discussed, by mentioning a total of more than 900 crops or related plant species. All these testify to the author's extremely comprehensive knowledge of material. Therefore, it is surprising that *Pouteria domingensis* (Mamey colorado), the wide-spread fruit-tree in the Antilles, and even its processing for preserve industrial purposes is known, has been left out of discussion. According to the monographic elaboration of DAHLGREN and GLASSMANN, *Copernicia australis* Becc. is identical with *Copernicia alba* Morong, and also *C. palmata* is no else than a variant of the same species.

Notwithstanding all these, BRÜCHER's book is an extremely valuable work of modern genetical views, endeavouring to cover all the material; it is one of the most excellent modern and comprehensive works which have recently been written on tropical useful plants. It is to be emphasized as its merit that with special regard to the demographic explosion that can be expected to occur in the tropical developing countries it suggests and describes several such useful plants and not-traditional food plants which are suitable for developing them and which may well alleviate the future worries of food supply.

A. BORHIDI

EVANS, H.: Botanical prints, with excerpts from the artist's notebooks. San Francisco, W. H. FREEMAN and Comp., 1977, 70 pp, 29 black and white and 33 color plates.

The artist presented his works in numerous individual exhibitions and in a number of volumes of similar character, achieving international acknowledgement. His reviewers mention at the first place the appreciation acquired by him in the circle of botanists, then they continue the line with artists, art collectors and nature levers.

Let us, however, consider here his graphica only from the viewpoint of botany. The specialist's eye is accustomed to the detailed presentation in water-colour paintings. It was already years ago that among the researcher's coworkers also draftsmen made their appearance, who now carries out the drawing of black and white figures in a reliable manner. Moreover, the world of colour photographs, the picture of plants taken in their surroundings, and rich in tone, has become accustomed. When we are turning over the pages of EVANS' book, we get into an entirely different world from these. His plants, depicted on white pages, and standing by themselves, recall a tradition going back to the beginnings, the most conspicuous, however is his application of reduction, which follows from both attitude and techniques. This is from which his values, individual characteristics originate, but at the same time the limitations of the presentation as well. The artist is interested in the whole of the mode of growth, the "gesture" of the plant, and this is by which he produces essential impression on the viewer. Structural characteristics are also discovered and indicated sometimes, but unfolded only in particular cases. The artist has specific sense for emphasizing contrary phenomena; this may occur in form or colour, or sometimes in the bizarre character of the gesture.

For the man of science the lino cut is strange or at least unusual, here however, it must be accepted as a key to the interpretation of these works. In the black and white illustrations the object is silhouette-like and the beauties of form appear clearly, in an abstract manner. The way of depicting the colour pictures based on 2—4 colours suggests other problems; the picture is very different from the nature of both the natural material and the one we are accustomed to. Hard contrasts can be seen, while individual colours, chosen in good taste, are dominant in the pictures. For the sake of effect, the artist gives up even the possibility of scale enlargement by pressing different colours on one another. Transitories appear only on some of the pages the petals of *Brodiaea pulchella*, or in the different way of treating the surface (*Rosa virginiana*; we are coming back to this later on).

The cultivators of the special science of botany come across a number of graphical techniques in the reference material, although there are only a few of them who recognize these graphical techniques and who can appreciate the peculiar taste in them. The possibilities and limitations of these techniques are always considered from the practical viewpoint, as the well or less well usable accessory devices of the specialized literature. Undoubtedly, the justification of lino-cuts is questionable on the part of the specialist if we consider these pictures as botanical illustrations. When however, an artist specializes himself for plant portraits, it is natural that he himself choses the technique by means of which he depicts his objects and expresses himself. These works are independent picture-graphics; their creator may apply in a sovereign manner the means best fitting to his creative method. In studying this book, the question arises, however; why is it that these pictures do not bear in them the characteristic

marks of the style of lino cuts? For, by working in the flexible block of linoleum, the line — in accordance with the technique — is slightly restless; the block-like appearance of the homogeneous surfaces is disturbed by fine differences — both in a positive and a negative sense —; the nature of the material is not suitable for introducing evenly thin lines, for reproducing minutiae. Here however — surprisingly — all these do not cause any problem. In addition, it is vain to look for the traces of form of the printing block on the rigorously white paper of the book.

Besides all these, by turning the pages with interest, we can say it is above all the pleasant rhythm that draws the eye: the nice typography, the finely divided block of the types, the beautiful black-and-white pictures placed on the margins and on the facing pages the plant illustrations inprinted in compact colours. The quotations taken from the author's note book give an insight into the phases of making the illustration — into all the phases of both chosing the subject, composition, and producing the cut and the block, here included the quality of the paper, nature of the printing ink and the way of using the hand-press. In the meantime the artist tells us his view of art and portraiture of plants. Along with the individual pictures there are accurate data: the scientific name of the plant, the site of collecting and drawing, the year of producing the picture, the make of the paper, the number of copies, the size of lino block. From the latter it appears that, with a few exceptions (e.g. *Anemone patens*, *Viola pedata*), the blocks are drawn to scale; to half (e.g. *Viola papilionaceae*), or to a quarter (e.g. *Briza maxima*). The reduction of the black-and-white and of colour illustrations is in general different, that of the former ones is more pronounced. The view of one or the other colour portrait, nevertheless, surpasses the measure of the distance between the eye and the book page and would rather be suitable on a wall (e.g. *Carnegiea gigantea*), while certain of these portraits belong in the sphere of plane-decoration (for example, *Vitis vinifera*, Traminer). On the other hand, graphical pages can be objectively judged only on the basis of original impressions and here we deal with a book multiplicated by means of the printer's procedure.

For the botanist it is the view of the plants that represents value: the summarizingly depicted, characteristic proportions of the object, and the "gesture" which is also a confession of the mode of life of the plant. In this respect, a lasting impression is made, for example, by *Carnegiea gigantea*, *Bambusa multiplex*, *Polypodium scouleri*, *Pinus strobus*, grass species indetermined (p. 38), *Viola papilionacea*, *Narcissus* hybrid, etc., with their summarily, powerful expression. It was, however, unfortunate to include in the series the *Helianthus annuus*, *Tulipa gesneriana* and a few other pages. While in *Eschscholzia californica* and *Dianthus caryophyllus* the demonstration of the characteristics of the leaf and the petal is beautiful, in the picture of *Rosa virginiana* that is unsuccessful from the viewpoints of both botany and art form.

When seeing the quiet illustrations, summarizing with unbroken lines, we may also miss something: the artist is in debt of providing us the experience of seeing sketches. Considering that creative works of graphic arts are discussed here, we could acquire a picture of the artist's workshop not so much by means of words as by drawings in pencil. These are some times able to tell us more about the intention of the artist, the genesis of creative work and about the object than do the finished works.

Zs. Bunke

Hirose Hiroyuki et al.: Illustrations on the japanese fresh-water algae. — Uchidarokakuho Publishing Co., Ltd. — 1-2-1 Kudankita, Chiyoda-ku, Tokyo, Japan. 1—959, with 64 illustrations in colour, in 8 coloured plates; with numerous tables and with drawings on all the algae.

The number of algal taxa observed in Japan can be around 3800. This book describes these algae living in fresh waters. The first volume of the book was published in a very handsome layout, in 1977. In the first volume, *Bacillariophyceae* did not receive space. Their fresh-water taxa, about 1500 in number, will be given in the second volume.

In the first volume 2308 fresh-water algal taxa, with figures, short characterization, and mention of the biotopes, occurrences, can be found. The figures are placed on the left-hand pages, while the descriptions on the facing pages, thus the book can be used with comfortable and without ambiguity.

Following the figures, the characterizations and remarks, some guidance, advice with respect to fresh-water algae is given. Moreover, the history of the Japanese research into algae is also given. The ample literature occupies 43 pages, and the majority of the many hundreds of works quoted are of Japanese authors. The works of authors from other countries have been given space in the volume when they have helped in the work of determination. The work ends with name and subject indexes in Japanese and in English.

The taxonomical composition of the fresh-water algae of Japan differs from that observed in Hungary. In Japan, after *Bacillariophyceae* consisting of some 1500 taxa, there come *Conjugatophyceae* of 1132 taxa. Cyanophytes of 443 taxa stand in the third place. The number of Chlorophytes, which are very frequent in Hungary, is only 359. There is only one more algal group, *Euglenophyceae*, which is represented by taxa over 100, that is 135. The number of *Charophyceae* taxa is 74, that of *Xanthophyceae* is 49, *Chrysophyceae* 47, *Dinophyceae* 35.

The work is written in Japanese; it contains only a summary of some two pages in English. Nevertheless, we can turn the pages of this very instructive huge volume of beautiful layout, and wonderful illustrations with great use, for the figures speak for themselves. The authors have accomplished a great work and deserve the fullest appreciation: AKIYAMA MASARU, HIRANO MINORU, HIROSE HIROYUKI, IMAHORI KOZO, IORIYA TERU, KASAKI HIDEO KOBAYASHI HIROMU, KUMANO SHIGERU, TAKAHISHI EIJI, TSUMURA KOHEI, YAMAGISHI TAKAAKI.

T. HORTOBÁGYI

FRANK A. LOEWUS and V.C. RUNECKLES (eds): The structure, biosynthesis, and degradation of wood.
Recent Advances in Phytochemistry. Volume 11. pp. 527, fig. 229. Plenum Press, New York, 1977

This book comprises the material of the selected lectures delivered at the sixteenth annual meeting of the Phytochemical Society of North America, in Vancouver, August, 1976. The book containing 11 chapters deals in detail with the structure, biosynthesis and degradation of wood, and reviews the recent scientific results till 1975. These chapters have a common feature, namely the emphasis has been placed upon the living tree and the changes which it undergoes in its life and degradation.

The first part of this volume is concerned with a review of the ultrastructure of the cell wall, then the chemical structure and biosynthesis of carbohydrate polymers, glycoproteins, lignin and lipid polymers in other words the major components of wood and woody cell walls are discussed.

In the second part of the volume a particular emphasis is placed upon the secondary changes which occur within the wood, including

— the influence of various environmental conditions during growth;
— the degradation of cell wall carbohydrates by micro-organisms;
— the microbial degradation of lignin;
— the cytological and anatomical changes by insects and pathogens.

The final chapter deals with the potentials and practicalities, successes and failures in the development of commercial wood products, emphasizing those materials which can be obtained directly as extractives or by treatment of wood.

Titles, authors' name and content of the individual chapters are outlined as follows:

1. *Wood Ultrastructure in Relation to Chemical Composition.* COTÉ, W. A. (pp. 44, fig. 39, ref. 52)

The general chemical composition of wood, the physical features of each chemical component are described. The various cell wall structure of the fibers and tracheids formed within the tension and compression wood of some coniferous and deciduous species are examined. Moreover, the author presents the distribution of the main chemical components within the cell wall layers.

2. *The Biosynthesis of Cellulose and Other Plant Cell Wall Polysaccharides.* DELMER, D. P. (pp. 32, fig. 6, tabl. 7, ref. 105)

The theoretical considerations of plant biosynthesis are presented with a view to the possible synthesis of the matrix component in vivo and in vitro. Between the special problems of cellulose synthesis the author deals with the fundamental questions of the biosynthetic studies and the possible substrates. Furthermore, he describes the recent results obtained in the research of the non-cellulotic polysaccharides of cotton fibers.

3. *Structure, Biosynthesis, and Significance of Cell Wall Glycoproteins.* LAMPORT, D. T. A. (pp. 36, fig. 18, tabl. 11, ref. 50)

The author has studied the structure of extensin, the hydroxyproline-rich glycoprotein. Moreover, the role of extensin in the life-functions of some algae and sea-weeds has been discussed and elaborated. According to assumptions the proceeding of extensin and collagen, the starting materials and conditions of their biosynthesis are fairly similar. This appears to be justified by the results of amino-acid analysis of these two materials. On the basis of experiments it can be supposed that the origin of glycoprotein (extensin) is a primary step in the origin of the eukaryotes.

4. *Degradation Products of Protolignin and the Structure of Lignin.* AKIRA SAKAKIBARA (pp. 22, fig. 8, tabl. 5, ref. 57)

The author studied the products of hydrolysis with dioxane and water, and the catalytic hydrogenolysis of protolignins. He examined the effect of the catalytic hydrogenolysis and oxidating degradation in some deciduous and coniferous species. He mentions in particular the general chemical properties of the compression wood lignin and the quantitative differences between the individual components, as compared with normal wood.

5. *Biosynthesis of Lignin and Related Monomers.* GROSS, G. G. (pp. 43, fig. 12, tabl. 6, ref. 166)

The author deals with the monomers, the fundamental steps of the lignin biosynthesis. He discusses in detail the necessary conditions for the phenylalanine-cinnamate synthesis (deamination, enzymes which promote the hydroxyl and methyl substitution, the enzymatic hydrolysis of cinnamic acid into alcohol, and the polymerization of these alcohols into lignin). Furthermore, the author describes the relation between the tissue specificity of enzymes and the lignification. Finally, he mentions some taxonomic considerations.

6. *Lipid Polymers and Associated Phenols, Their Chemistry, Biosynthesis and Role in Pathogenesis.* KOLATTUKUDY, P. E. (pp. 62, fig. 25, tabl. 9, ref. 122)

The author makes known the methods which are suitable for separation, degradation of lipid polymers, and for analysis and structure determination of monomers. He made investigations to determine the components and structure of cutin and suberin. The author mentions the possible role of enzymes which depolymerize lipid polymers in pathogenesis.

7. *Secondary Changes in Wood.* HILLIS, W. E. (pp. 61, fig. 1, ref. 365)

The author describes the heartwood formation within the sapwood. He accentuates the resistance of heartwood is increased of the accumulation various non-structural components (resins, colouring agents and tannins).

8. *Degradation of Polymeric Carbohydrates by Microbial Enzymes.* REESE, E. T. (pp. 57, fig. 18, tabl. 12, ref. 83)

The author deals with a central question concerning the enzymic degradation of polymeric carbohydrates, namely, that organism are capable of consuming foods which can be transformed into a liquid state, so the application of solid substrates has not been resolved. The application of some water-soluble enzyme products may be able to resolve this problem.

9. *Advances in Understanding the Microbiological Degradation of Lignin.* KIRK, T. K., CONNORS, W. J. (pp. 26, fig. 5, tabl. 3, ref. 63)

The authors studied the effect of environmental factors on the fungal and microbiological degradation of ^{14}C-labelled lignin. A particular emphasis is placed upon the degradation of lignin by specific fungus and the industrially applicable degrading processes.

10. *The Non-specific Nature of Defense in Bark and Wood during Wounding. Insect and Pathogen Attack.* MULLICK, D. B. (pp. 52, fig. 38, tabl. 2, ref. 48)

The author studied the wounds caused by the balsam woolly aphid as a model of pathogen and plant interactions. He studied the pigment formation in the periderm as an effect of injury, the defending mechanism in the plant tissues during the tests (development of non-suberized impervious covering and bark, etc.). When injuries are deep, the outer annual rings of the cambium and sapwood also participate in the callus formation.

11. *Utilization of Chemicals from Wood: Retrospect and Prospect.* HERRICK, F. W., HERGERT, H. L. (pp. 74, tabl. 5, ref. 206)

The authors give a comprehensive survey of the wood constituents (i.e. terpenes, resins, waxes, colouring agents and tannins), carbohydrates and their derivatives (wood sugar, furfural, levulinic acid, etc.), and chemical products derived from lignin (vanilin, guaiacol and other fenolic compounds); all these constituents can be recovered by direct (extractive) processes. As to the utilization of waste wood and pulp, in the future the biochemical processes may be able to resolve this question.

Each paper presented no doubt, will be of interest to researchers providing new information in their special field. Nevertheless, we wish to stress the importance of the studies of LAMPORT, D. T. A. and KIRK, T. K.—CONNORS, W. J. The former reports on new experimental and theoretical information with respect to the common ancestry of extensin and collagen. The latter is concerned with the newest enzymatic processes and pathways for microbiological degradation of lignin.

This book is recommended to biologists, biochemists, chemists, xylotomists, phytobiologists, and researchers dealing with forestry and wood industry.

K. BABOS—J. HORVÁTH

Růžička Jiři 1977: Die Desmidiaceen Mitteleuropas. Bd. 1, 1. Lieferung, K. Schweizerbart'sche Verlagsbuchhandlung (Nägele und Obermiller). Stuttgart, 292 pp, 18 figures in the text, 44 plates with drawings; price: 138 DM.

The tendency has since long been observable that certain branches of algology become independent, that is, separate branches of science. The independent branches of science are kept in unity and separated from other branches by the object of the examination being identical and by the common method of investigation. Algae comprise such a large systematic domain that a taxonomist is able to know only a smaller group of them in detail. The methods of sampling, preparation, and processing are also different from case to case, mainly since the electronmicroscope can also be found in the storehouse of luckier algologists. Diatomology, which had been the earliest to get separated, was not long ago followed by desmidiology the first independent congress of which was held in 1971.

Desmidiology has a few standard works: W. West and G. S. West 1904—1932, Krieger 1933, 1935, 1937, 1939; Kossinskaya 1960. Beyond all these, however, there was a great need of such book that could offer an up-to-date critical survey, and a revision of the numerous taxa. In reading the first volume, it is a great pleasure for us to greet the long awaited work in that of Růžička. Specialists, dealing only with off-European materials may consider as its shortcoming that the book comprises primarily only occuring in Central Europe. Several viewpoints make us, however, agree with the author's attitude of decreasing the volume of the book. It enough to think only of the circumstance that the elaboration of *Desmidiaceae* outside Europe has already been started at several places (Hirano, Bicudo, etc.), further, that the book would have been increased in volume and could have been published only much later, involving that its price which is anyhow not negligible would have further increased.

The aim of the book is to make it possible that *Desmidiaceae* species found or expected to be found in Central Europe are determinable from it. The characteristics of the species outside Europe are also touched upon in short, but a detailed characterization of them is dispensed with. The work is primarily of a taxonomic subject, but short physiological, citological, ecological and phytogeographical remarks are also to be found when they provide assistance in the characterization of the species.

The author helps the recensist's work to a great extent by listing in the Preface the differences point by point occurring in his book with regard to determinations as compared with earlier textbooks on algae.

The first such characteristic is that the International Code of Botanical Nomenclature is strictly observed. It is regrettable that such a natural obvious requirement can be registered as a merit but it is a fact that a wrong conservatism is prevailing in algology. Occasionally, even the most excellent algologists ignore or badly interpret the priority rule, injure the rules of valid publication, etc. Růžička, from the viewpoint of a *Desmidiaceae* researcher, reviews and interprets one by one the rule most frequently unobserved. Unfortunately, the Code is not, or only partly, understandable for those who have never been engaged in nomenclature as yet; it is unavoidable that we should have an expertise guidance in the jungle which is almost like the language of legal men. In this respect, not only desmidiologists but also algologists can make use of this work.

The second emphasized characteristic is the monothetical conception of the taxa; the sum of each superior taxon comprises those of the subordinated ones, which is in agreement with the instructions of the Code (Item 25). Dissimilarly to this, traditional algology follows a polythetical conception; according to this, the higher taxon, for example, species is considered as regular and to this the subordinated taxa, for example, varietas or formae are ordered as exceptions or deviations. The taxonomic keys of the polythetical conception are essentially worse, misleading. It was only the species that were built into a traditional key, varieties and forms which made the exceptions were not, whereby they sometimes were not even able to be determined on the basis of the key. Besides the difficulties of language, this has been another cause that a considerable part of the algologists do not determine on the basis of the key, but looks at only the figures and translates only the species description. If we work not on the basis of the taxonomic key but only on the basis of the figures, then we may fall into great errors sometimes since not all the characteristics are such that they can be depicted satisfactorily. The spread of the monothetical conception will presumably change this absurd situation for the better.

The third characteristic: the author evades making categorical generalizations the validity of which has not been proved, and instead of this, endeavours to point out the shortcoming of our knowledge, and the necessity of further examinations. His pointing out the problems is not accompanied by a blowing up of them and by his calling into doubt of the possibilities and use of further researches; that is, the argumentation does not lead to nihilism but has a positive outlook.

The fourth characteristic is an objective supervision of the systematic characters. Here the author puts an emphasis on his opinion that taxa can be based on nothing else but on genetically fixed, heritable characters. The variable appearances which are not heritable but come into existence under the influence of for example the environment, cannot be ordered even into the variety or form values, but their name is morph without any systematic value, and no author's name can be written to them. Unfortunately, this view has not yet become satisfactorily general in algology. New taxa come into existence on the basis of little morphological differences observed on a single specimen. A great majority of these prove to foredoomed to failure due to the above causes. There were several researchers who one after the other pointed out that the use of quantitative characters should be avoided also in algology. ALLEN (1958), for example, proved of one of the main taxonomic characters — the width of filament — of the *Spirogyra* species that in the species examined it depends on the level of the polyploid individuals. Also RŮŽIČKA mentions that the biradial and triradial forms of the same species, which occasionally are of this form also because of the differences in the ploidy level, cannot be considered as separate taxa. To them he uses the names of no taxonomic value, *viz.* facies 2 and facies 3. The taxa named varietas "maior" or form "minor" need revision by any means because it is not right to use the strongly undecided differences in sizes as a basis for determing taxa. It is increasingly evident that if algology wants to create a lasting system, it cannot do it without having a certain form of cultures. No decision can be made whether a character is reliable or not if there is no culture. The picture of morphological variability is also larger if obtained on the basis of cultures.

The fifth characteristic is that the author always derives the description of the taxa from the original diagnosis, and not from the later monographs which are more or less different from the original. Unfortunately, there are only very few algologists who follow the same view and therefore, there has arisen a great chaos in respect of certain taxonomical groups.

The structure of the material is as follows: The name of the species is followed by the description of the species. The enumeration of the separating characters is very useful because in the knowledge of them even the less skilled taxonomist can determine the species with more certainty. Under the heading "Taxonomy", the most essential knowledge of taxonomy and nomenclature is discussed. In the general textbooks on determining taxa this part is most needed by the user, that is where the author would point out the contradictions occurring in specialized literature and would provide a basis for his own position. Here the merit of the book, mentioned earlier, is realized in that RŮŽIČKA does not declare but takes a stand. Under the heading "variability", we receive a comprehensive picture of the variability of the characters of the individual taxa. In case of species, the author describes here the infraspecific taxa occurring outside Europe. In the chapter entitled "occurrence", the ecological requirements and the distribution of the specias, with special regard to Central Europe, are discussed. The plates with drawings are of very nice design, and a considerable part of variability is represented also in pictures. The keys are of a good structure; oue point separates on the basis of several characters at the same time, thus the possibility of error is smaller.

The reader's work would be considerably easier if in the register to be found at the end of the book, not only the page numbers but also the numbers of the tables and figures would be indicated. Further unnecessary thumbing of the book could be spared if the keys indicated the page numbers instead of the serial numbers of the taxa. It would have been a pleasure for me to read about the results of the taxonomical researches carried out with the electron microscope, first of all the scanning electron-microscope, about their perspective, and the conflict arising from the different possibilities of the classical and the electron-microscopical methods. The book is in German, which to a certain extent prevents its use on a large scale. This disadvantage is, of course, not serious since the taxa are related to Central Europe. The majority of the textbooks on taxonomical determination are written in German, therefore algologists know the language anyway.

Taking all in all, the reader will receive a textbook of such outlook that serves useful knowledge not only to researchers into *Desmidiaceae.*

L. HAJDU

SIMON, T.: Vegetationsuntersuchungen in Zempléner Gebirge (Abgrenzung zönologischer Einheiten unter Anwendung quantitativer und rechentechnischer Methoden; Vorstellung der zytozönologischen Analyse). In: Die Vegetation ungarischer Landschaften, 3 vegetation maps, 22 tables, 351 pp, Akadémiai Kiadó, Budapest 1977.

The subject of examination, Zemplén mountain, lying in the North-Eastern part of Hungary, is of volcanic origin. The present book is an analysis of the forests and rock meadows

rich in Carpathian floral elements. The work is characterized by a complex, many-sided approach: the phytocenological analyses are well supplemented with other related analyses.

In the introductory part, those chapters are contained which deal with the general description of the area; the geological, geographical-geomorphological, hydrographical and climatical characterization and that of soil science; the historical background of floral and vegetation research, and also the description of flora and vegetation on a large scale. The plant cover is discussed by an approach from zonal and azonal (edaphical) viewpoints. The author puts emphasis on the statistical elaboration of cenological tables; similarity in vegetation is expressed by chi^2-values and the cenological distance by its reciprocal value. The large volume of the material made the computer procession necessary; after Polish authors (KULCZYNSKI, CZEKANOWSKI and others), the cenological contexts are illustrated graphically, in the form of dendrites.

The hard core of the work is the cenological elaboration related to rock meadows and forests (pioneer rock meadows rich in mosses, partly communities described by the author, and partly cenoses which are slightly known yet). The meadows and rock shrubs examined are mosaic — like components of the forest steppe; economically they are less valuable but from the viewpoints of nature preservation they are increasingly more so. The essential part of this chapter and of those dealing with forests is the soil ecological analysis. The chapter dealing with forests is also abundant in original material (for example, montane beaches). A specific feature is the silicate rock forest (*Sorbo-Quercetum petraeae*) described here (the presence of which could be stated by the reviewer also in Mátra mountain); this silicate rock forest is an equivalent — occurring in the Northern Mountain Range — of *Luzulo-Ornetum* (occurring in the basalt mountains around the Lake Balaton). A phytocenological classification of grasslands and forest communities according to the Zürich—Montpellier school and to the Hungarian cenological system is also attempted by the author.

It should be remarked that giving the cenological pictures in the form of tables among text parts is not successful, interruption is to the disadvantage of surveying. The drawings and photographs are excellent and serve better understanding well, while the photographs could have deserved a better quality of paper.

After TISCHLER and others, the author carried out also the cytoecological analysis of the vegetation units (by giving at the same time an appreciable historical survey of this question as well), emphasizing that such an analysis into cenotaxa covering a large scope (e.g. association) may, however, lead to contradictorily results. Accordingly, the analysis of smaller entities (synusiae), or of so-called ecological species groups is of more expectation. Therefore, ecological species groups are used on the basis of the water supply (W) and pH-value (R) of the habitats. It is interesting that extreme W-values (thus, either low or high values) entail a higher polyploidy ratio. A definite relationship between the diploid/polyploid ratio and W-values expressing the water ecology of the associations examined in the Zemplén mountain could be stated. On the other hand, the author succeeded in pointing out that in the communities which developed in basic soil polyploids are almost exclusively dominant; anyhow, of the two factors, the role of water seems to be more important.

The peculiar postglacial residue character of the region could be characterized also by palynological (pollen-analytical) examinations. The spatial relations of the vegetation units can be studied on two detailed vegetation maps (1 : 10 000) and on a surveying map.

Mosses play an in general greater part in succession and soil preparation (towards the rock meadows), and in the forests as a result of the widely-covered moss synusiae, and moss cushions) of the Zemplén mountains. Therefore, the author pays great attention to bryocenology and bryoecology. The data related to 88 species and 20 plant communities with respect to soil moisture content and pH distribution may well invite the interests of bryologists.

The book can be recommended not only to the specialist community of botanists but also to readers working in practice. The communities, forest types are important also for forestry practice. In order to facilitate the acquiring of their knowledge, the author prepared the taxonomic key of the communities, by means of which a forester specialist, for example, can quickly determine where a concrete stand belongs typologically. Practice is served also by wood-volume data related to 27 types of forests.

The book may well be recommended to all Hungarian and Central-European botanists, and even to a wider sphere, comprising not only specialists, because of its novelties more general in nature, an e.g. in relation to methodology.

G. FEKETE

SECOND INTERNATIONAL CONGRESS OF SYSTEMATIC AND EVOLUTIONARY BIOLOGY

(1 CSEB-II)

THE SECOND INTERNATIONAL CONGRESS OF SYSTEMATIC AND EVOLUTIONARY BIOLOGY (I CSEB-II) WILL BE HELD AT THE UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER, CANADA, 17—24 JULY 1980.

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2. ORIGINS AND EVOLUTION OFTHE NORTH PACIFIC MARINE BIOTA
3. EVOLUTION OF REPRODUCTIVE STRATEGIES
4. EVOLUTIONARY EPIGENETICS
5. EVOLUTION OF COMMUNITY STRUCTURE
6. GREEN ALGAE AND LAND PLANT ORIGINS
7. MACROMOLECULAR MECHANISMS IN EVOLUTION
8. ALLOZYMES AND EVOLUTION
9. COEVOLUTION AND FORAGING STRATEGY
10. EVOLUTION OF COLONIZING SPECIES
11. RARE SPECIES AND THE MAINTENANCE OF GENE POOLS
12. PALEOBIOLOGY OF THE PACIFIC RIM

ADDITIONAL SYMPOSIA MAY BE INCLUDED.

SESSIONS FOR CONTRIBUTED PAPERS AND FOR PAPERS IN SPECIALIZED FIELDS, TAXONOMIC AS WELL AS METHODOLOGICAL WILL ALSO BE ORGANIZED.

THOSE INTERESTED IN RECEIVING AN INFORMATION CIRCULAR IN THE SPRING OF 1979, SHOULD WRITE TO THE FOLLOWING:

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Резюме

КСИЛОТОМИЧЕСКИЕ ИССЛЕДОВАНИЯ НЕКОТОРЫХ КУБИНСКИХ ДРЕВЕСНЫХ ВИДОВ. II

К. БАБОШ и А. БОРХИДИ

Авторы описывают самые главные внешние морфологические свойства, распространение и экологию, а также анатомические свойства ксилемы у 8 древесных видов кубинской флоры: *Curatella americana* L. (*Dilleniaceae*), *Luehea speciosa* Willd. (*Tiliaceae*), *Alvaradoa amorphoides* Liebm. ssp. *psilophylla* (Urb.) Cronq. (*Simarubaceae*), *Cyrilla* L. (*Cyril-racemiflora laceae*), *Lysiloma bahamensis* Benth. (*Mimosaceae*), *Myrsine cubana* A. DC. (*Myrsinaceae*), *Mastichodendron foetidissimum* (Jacq.) Cronq. (*Sapotaceae*), *Linociera bumelioides* Griseb. (*Oleaceae*).

ЭЛЕКТРОННОМИКРОСКОПИЧЕСКОЕ ИССЛЕДОВАНИЕ CHLAMYDOMONAS MEDIA KLEBS (*CHLOROPHYTA*) ВО ВЛАЖНОЙ ФАЗЕ

А. ЭКЕ, Е. КАЛЬМАН и Ж. П. КОМАРОМИ

Вновь развитая электронномикроскопическая техника дает возможность исследовать объекты в приближенных естественных условиях. Авторы изучали возможности морфологических изменений у водарослей, причиняемых електронным облучением. В случае *Chlamidomonas media* Klebs на пртяжении опыта, авторы не обнаружили никаких значительных морфологических изменений.

НАКОПЛЕНИЕ ЭЛЕМЕНТОВ ВИДАМИ ТИНЫ В БАЛАТОНЕ

М. КОВАЧ

Виды тин (*Ceratophyllum submersum*, *Hydrocharis morsus-ranae*, *Myriophyllum spicatum*, *Najas marina*, *Potamogeton pectinatus*, *P. perfoliatus*, *Stratiotes aloides*, *Utricularia vulgaris*) часто втречающиеся в Балатоне, в зависимости от их способности к катионной селекции, а также от окружающей их геохимической среды, накапливают в своем организме в различном количестве исследованные биогенные элементы, вернее тяжелые металлы (N, P, K, Mg, Na, Fe, Mn, Zn, Sr, Pb, Cu). Плавающая тина способна накоплять тяжелые металлы в порядке 10^3, а также играющих роль в зутрофизации озера азота и фосфора в порядке 10^4-10^5. На основе этих исследований может быть определена биологическая индикация некоторых видов.

СРАВНИТЕЛЬНЫЕ ИССЛЕДОВАНИЯ ОБРАЗЦОВ ПЕРИФИТОНА, СОБРАННЫХ: В РАЗЛИЧНЫХ ТРОФИЧЕСКИХ ВОДАХ С ЕСТЕСТВЕННОГО СУБСТРАТА

Д. ЛАКАТОШ

Результаты, полученные от сравнительных исследований таксономии и биомассы образцов естественного субстрата (*Typha latifolia* L.) которые были собраны осенью 1974 года из различных по трофизму вод (озеро Ньекладхази ологотрофическое, водохранилище Оларети мезо-эутрофическое, рыбное озеро полгари эутрофическое и рыбное и рыбное озеро в Хортобади зу-политрофическое) находятся в зависимости от состояния эутрофизации исследованных водоемов. Автор определил, что сукцессионный процесс эутрофизации создание в одном определенном участке биотектона указывает не только на состояние трофизма а также и на аутосапробность. В данной статье автор указывает на скрытые перспективы, заключающиеся в проверке качества воды биотектона.

ДОПОЛНЕНИЕ К СВЕДЕНИЯМ О КУБИНСКИХ ВИДАХ РОДА *MELOCACTUS*

З. МЕСАРОШ

Автор дал монографическую обработку кубинских видов в 1976 году в **Acta Botanica Acad. Sci. Hung.** а также описание новых таксонов. В тоже самое время Арецес также описал два новых вида *Melocactus* с Кубы (*M. actinacanthus*, *M. holguinensis*) среди которых, последний оказался тождественным виду *M. jakusii*, описанному Месарошем. В статье автор включает новые таксоны в систему кубинских *Melocactus* а также дает новый более расширенный ключ к определению до сих пор известных таксонов.

ИССЛЕДОВАНИЕ СООТНОШЕНИЯ МЕЖДУ ВРЕДОМ ПРИЧИНЯЕМЫМ НАСЕКОМЫМИ И РОСТОМ ЛИСТЬЕВ ПРИ ПОМОЩИ ОПЫТНОЙ МЕТОДИКИ

М. НАДЬ

Статья содержит опытные моделированные исследования по вреду причиняемому листоедиными насекомыми. Автор за время вегетационного периода 1977 года мог вести наблюдения над изменением отверстий диаметром 2—3 мм, просверленных насекомыми, при помощи светокопировальной бумаги "Diazol S", на 800 листьях некоторых деревь кустарник и мягкостебельных. Автор определил, что вместе с площадью листа растет площадь отверстий. Степень роста различных частей листовой пластинки неодинакова, таким образом те отверстия, которые вначале имели одинаковую площадь были различного размера а также и различной формы. На основе этого автор мог разделить исследованные виды на три основных ростовых типа / апикальный, базальный и медиальный и два подтипа (абаксиальный, аксиальный). Повреждение листьев насекомыми в процессе роста листа постоянно расширялось и таким образом непосредственно приченeнный вред на средний вес одновременно с приростом, приходящимся на единицу поверхности листа, был значительно большим, чем количество органической массы, которую действительно сьели насекомые. Автор разработал математическое соотношение для определения действительной величины вреда причиненного насекомыми.

МУТАГЕННЫЙ ЭФФЕКТ ПЕСТИЦИДОВ
I. ЦИТОЛОГИЧЕСКАЯ АКТИВНОСТЬ ГЕРБИЦИДОВ КАРБАМИДНОГО ТИПА НА ЯЧМЕНЬ (*HORDEUM VULGARE* L.)

Т. ПУСТАИ и А. ВЕГ

Исследования проведены на ячмене (*Hordeum vulgare* L.) с девятью действующими началами гербицидов карбамидного типа (диурон, линурон, монолинурон, хлорбромурон, метоксурон, изопротурон, метобромурон, метабензтиазурон, хлороксурон) с целью изучения влияния на прорастание семян и цитогенетической активности.

Для каждого действующего начала гербицидов установлена летальная и $ЛД_{50}$ доза. Летальная доза колебалась в пределах от 300 до 1200 ppm, а $ЛД_{50}$ от 250 до 1000 ppm.

Использование метафазного метода для анализа аберраций хромосом позволило с большей точностью определить различную степень мутагенной активности гербицидов. Уровень мутирования колебался между 2,54 и 10,97%. Выход хромосомных аберраций при обработке монолинурон (10,97%), хлоробромурон (8,06%), метобромурон (6,68%) и метабензтиазурон (6,26%) превышал количество структурных мутаций хромосом (5,96%) при обработке этиленимином (2,3. 10^{-3}M), но ни в одном случае не достигал уровня мутирования) 12,06%) при облучении семян γ-лучами (10 000 р). С увеличением времени обработки семян растворами гербицидов метабензтиазурон, хлорбромурон и изопротурон наблюдается повышение количества аберраций. Возрастание концентрации раствора гербицидов приводило к изменению спектра перестроек хромосом. При этом увеличивается количество фрагментов. Все испытанные гербициды вызывают те же самые типы перестроек, которые возникали в опыте с обработкой этиленимином. Продолжительность времени обработки семян гербицидами не оказывало влияния на изменение типа хромосомных аберраций.

ЭЛИМИНАЦИЯ ХРОМОСОМ В АЛЛОПЛОИДНОМ ГИБРИДЕ ТАБАКА

Л. СИЛАДИ и А. Х. НАДЬ

Авторы получили «гаплоидные» растения в культуре ткани пыльников аллоплоидного гибрида *N. tabacum* (Ку) x *N. glauca*, у которого в результате элиминации генома хромосомное число вместо 2п=72 было 2п=48. Анализ кариотипа гапло идниы растений подтвердил что в этом гибриде сохранился геном *N. glauca*, а элиминация хромосом произошла из генома *N. sylvestris* и *N. tomentosiformis*.

Сравнительный анализ протеинов и изоэнзимов гаплоидных и исходных растений подтвердил, что в мейозе аллоплоида автосиндетические биваленты расходятся правильно, а также, что активность эстераз находится под контролем структурных и регуляторных генов. Взаимодействие между геномами до и после элиминации хромосом дает возможность предполагать наличие регуляторных генов.

ПРОДУКЦИЯ АЛКОЛОИДА ВИДА *DATURA INNOXIA* В КУЛЬТУРЕ ТКАНЕЙ

Г. ВЕРЗАР ПЕТРИ, ДИНЬ ХУЙН КЕТ и Е. СЕКЕ

Авторы выраживали культуры тканей из стеблей и корней на агаризированной среде Мурасиге-Скуг при освещении в 2 500 люкс, а также и в темноте. Они установили, что в культурах тканей, выращенных на свету содержание алкалоида выше. Однако в каждой культуре ткани количество алкалоида гораздо ниже, чем у исходного материала (одногодичные и двухгодичные культуры). В более значительном количестве можно было найти не этерифицированные и норсоединения. Среди аминокислот от непосредственных прекурсоров имелись только следы. Прибавление $3^{14}C$ фенилаланина тормозило образование алкалоидов, тогда как $2^{14}C$ асетат натрия хорошо встраивался и повышал содержание алкалоида.

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